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INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

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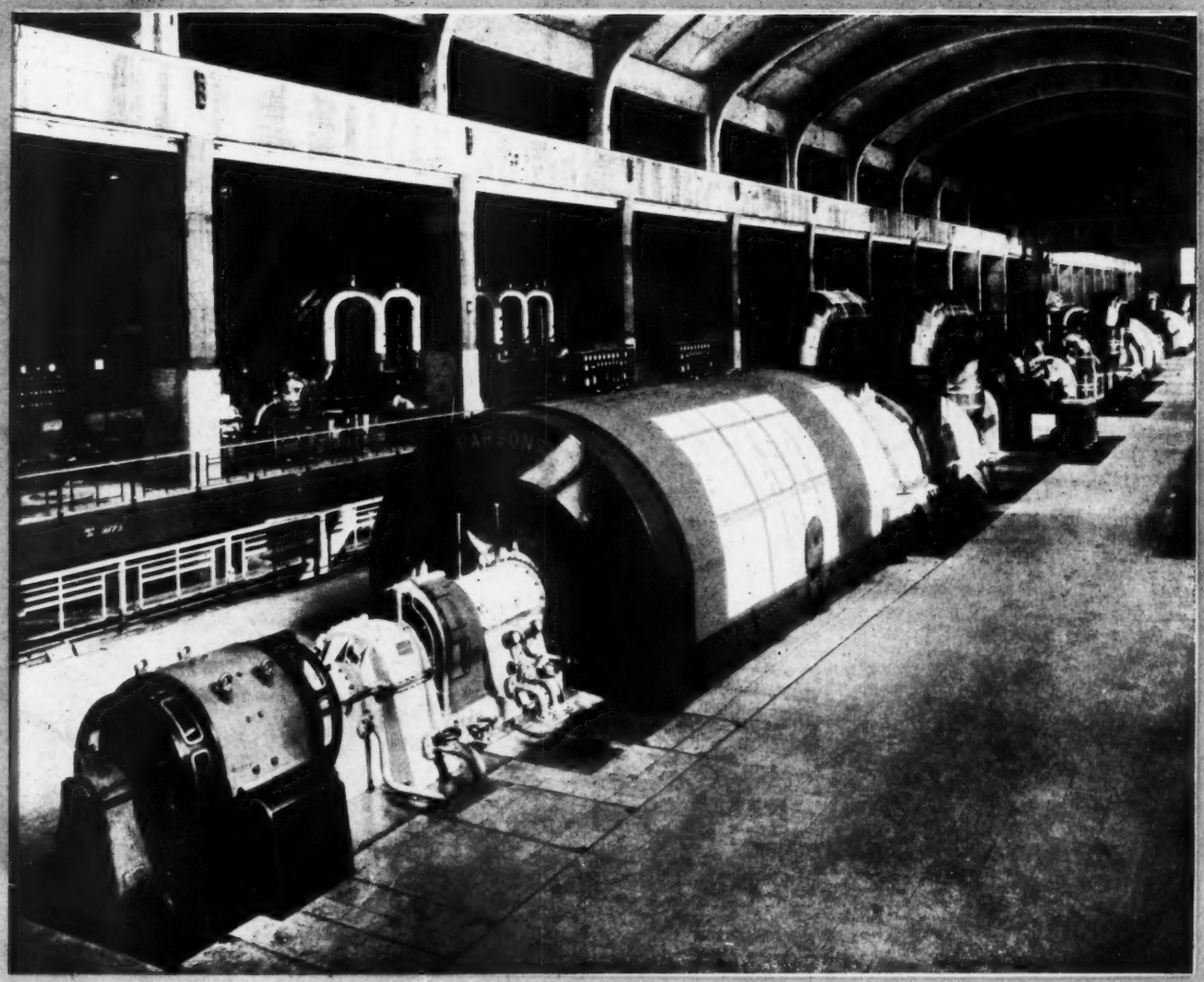

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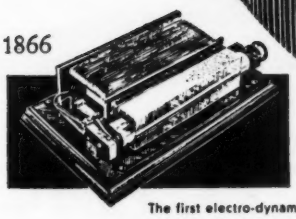
1866



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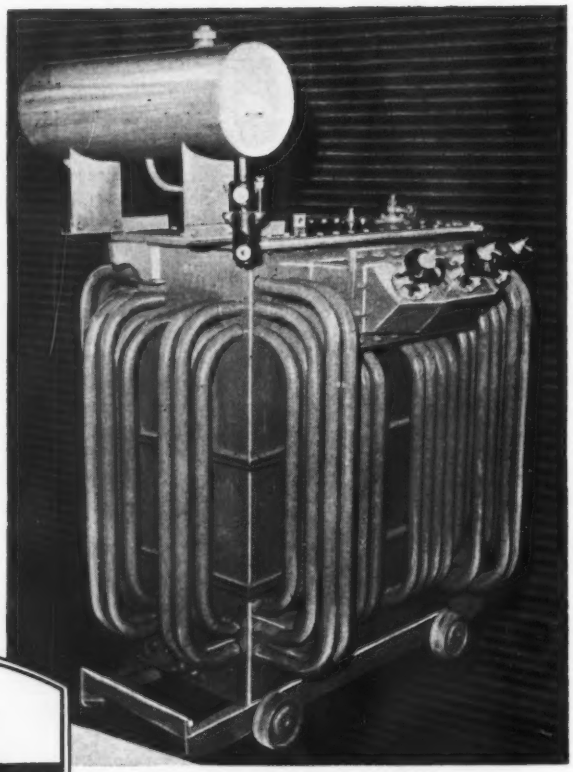

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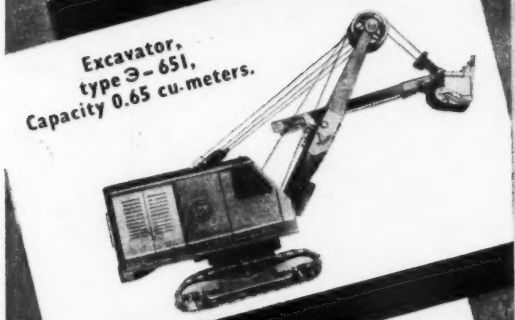

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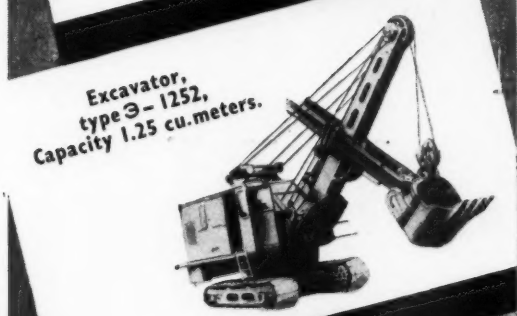
Capacity 0.65 cu.meters.



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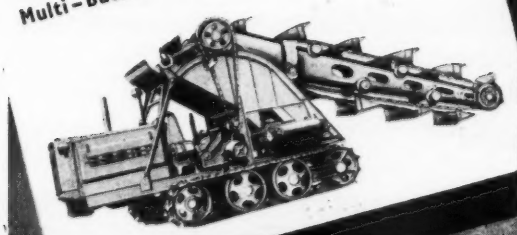

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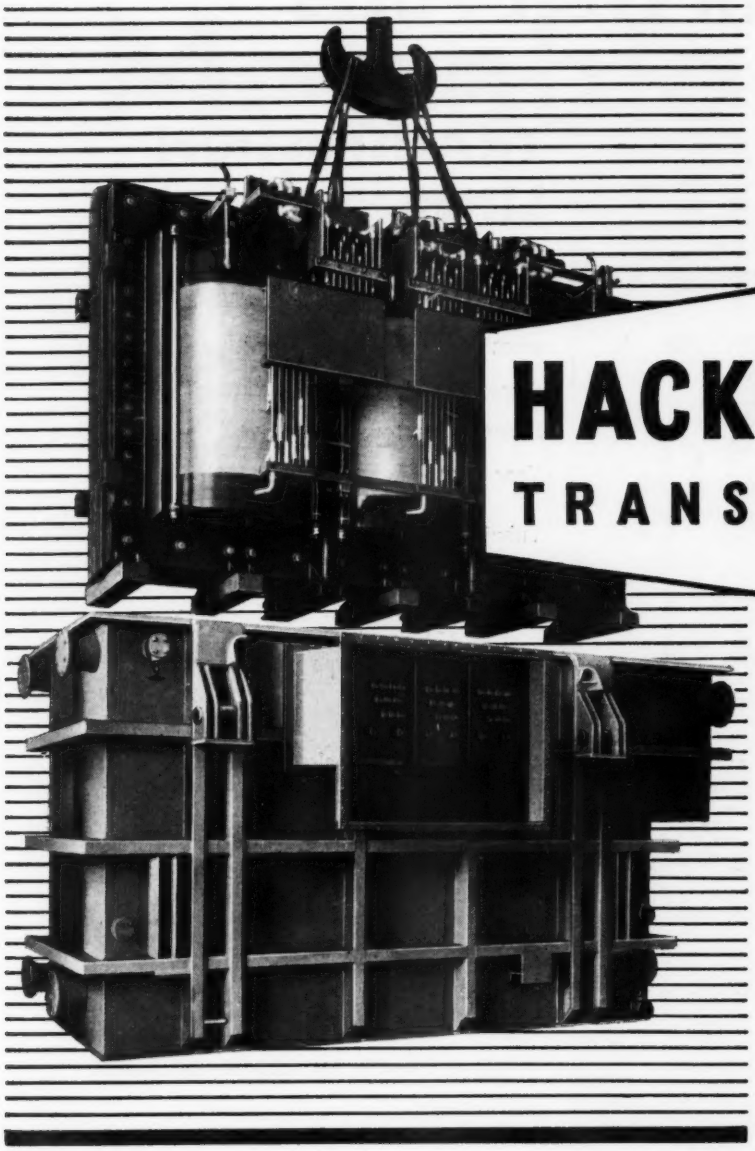

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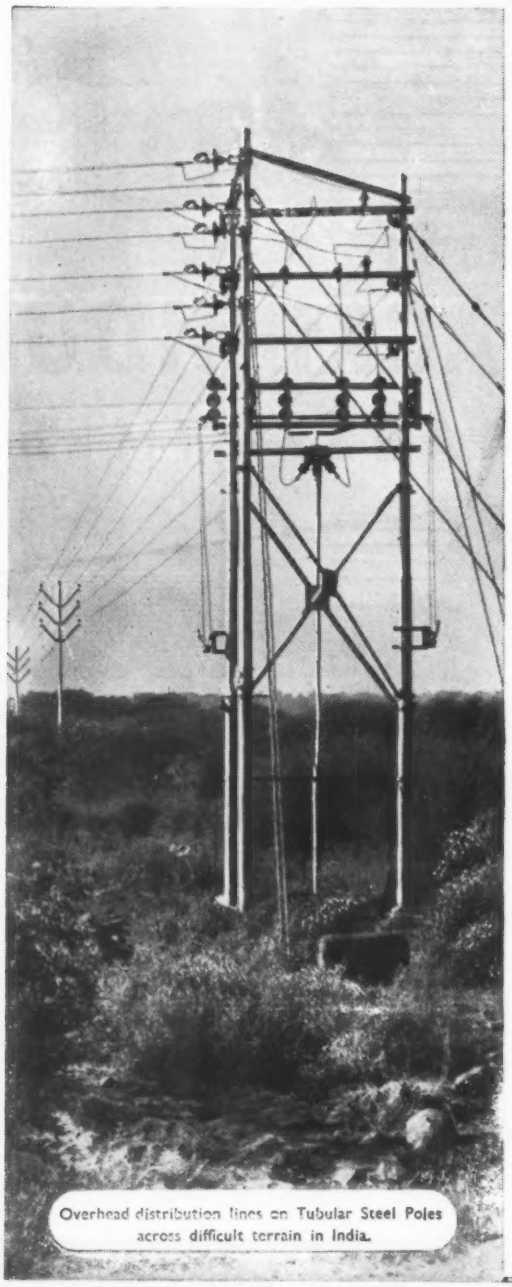

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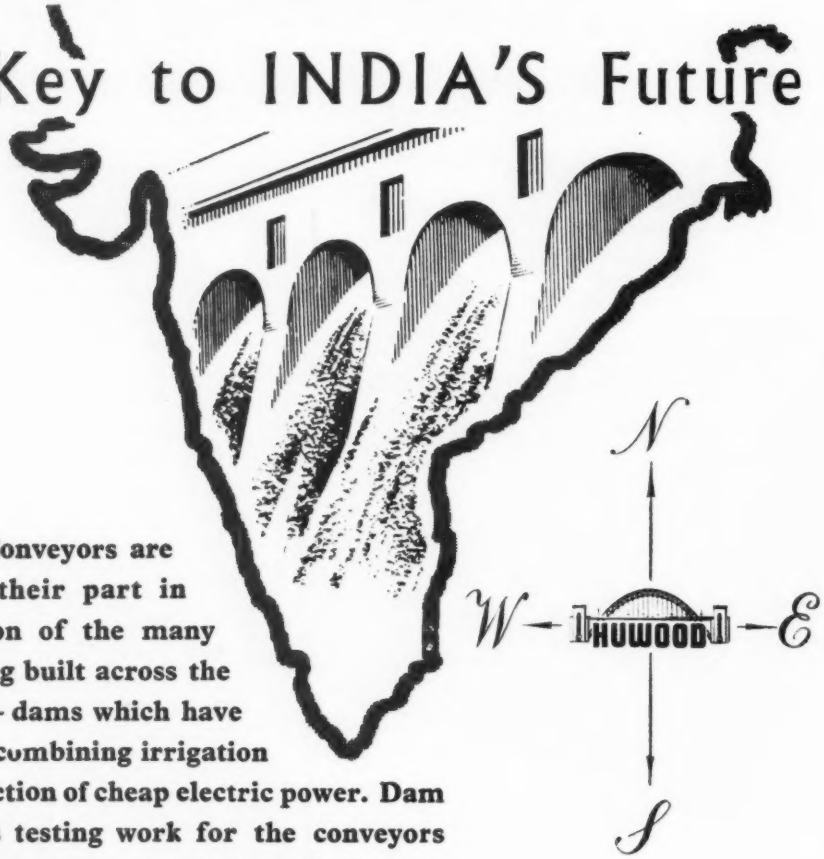

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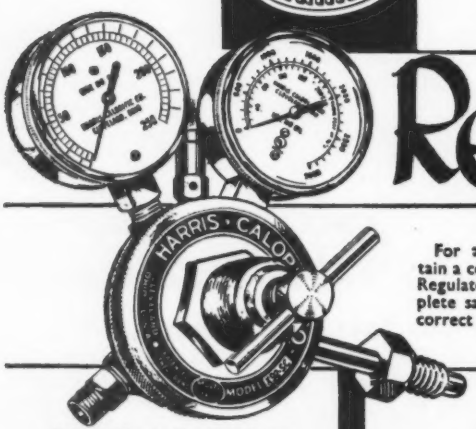

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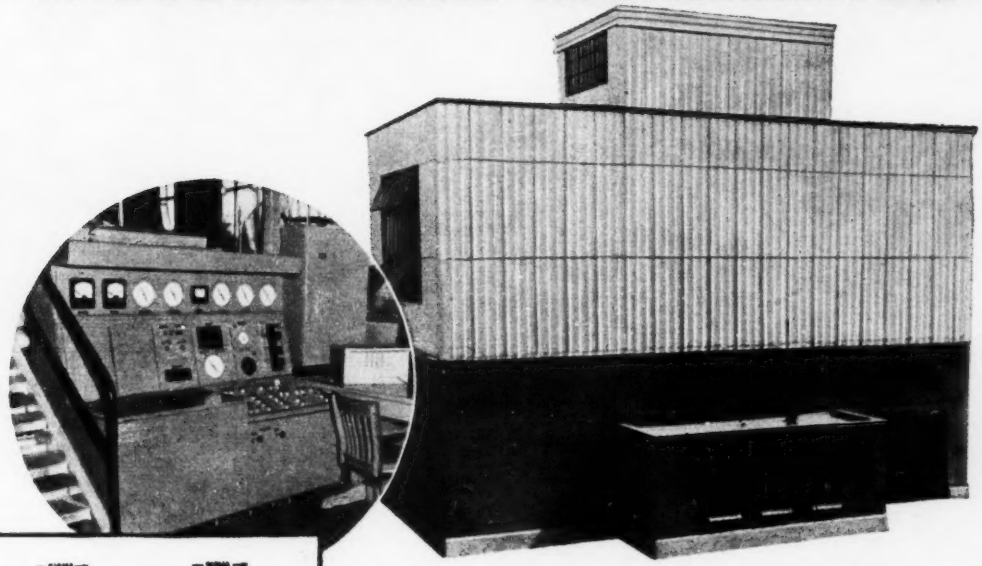

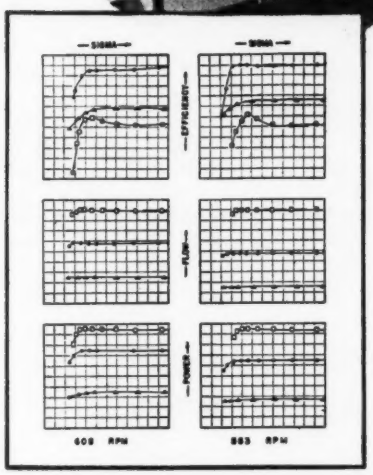

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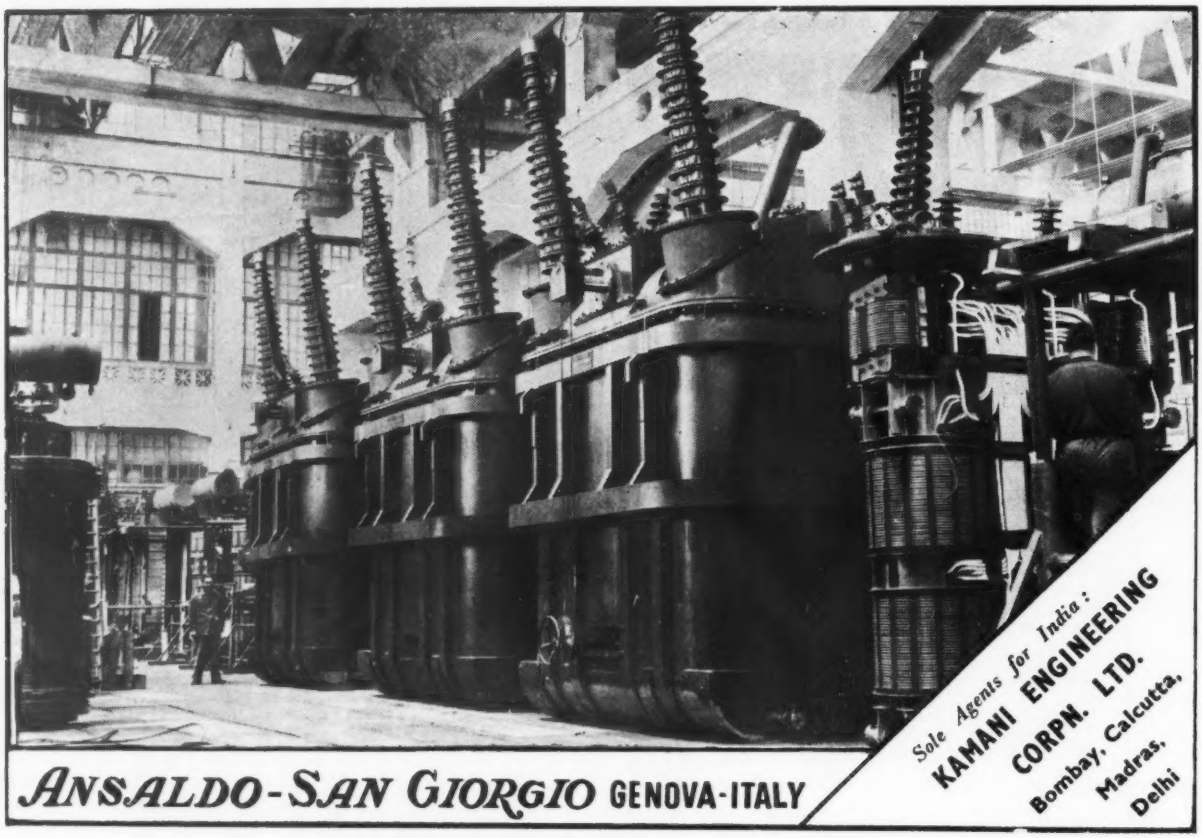

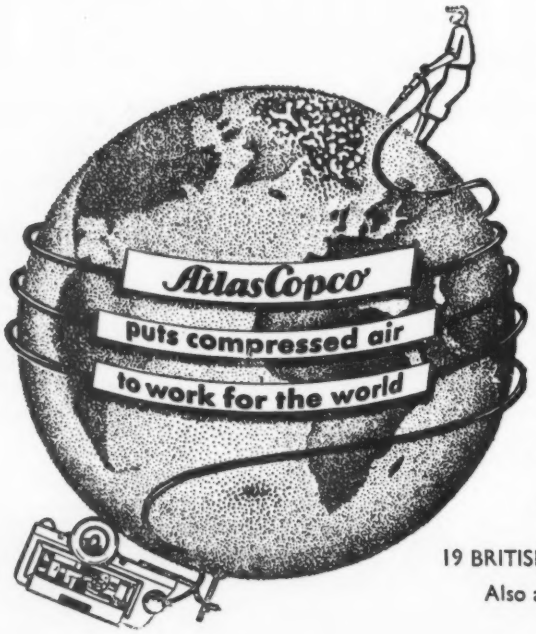

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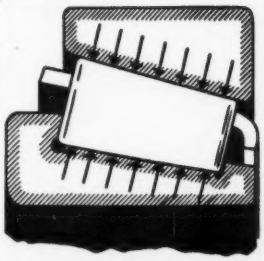

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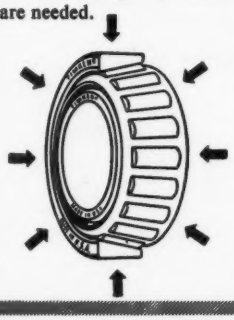

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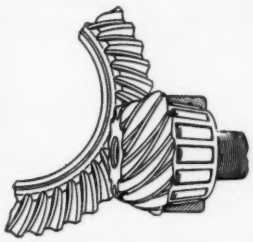

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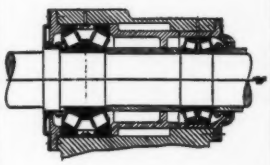

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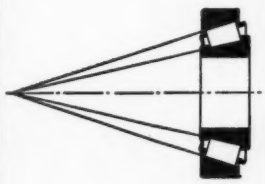

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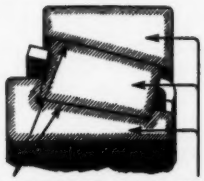

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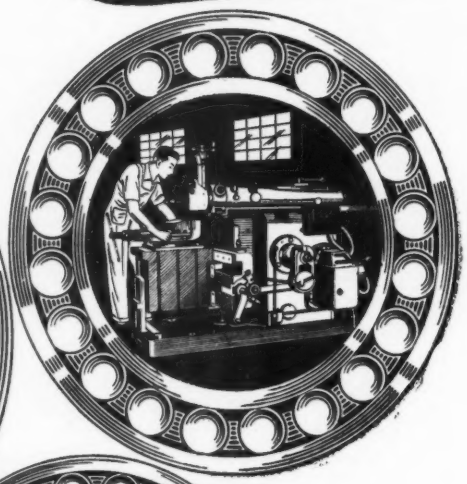

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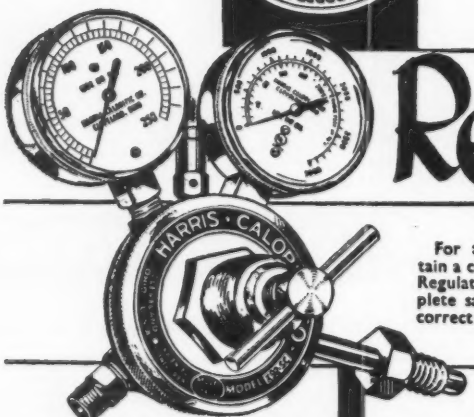

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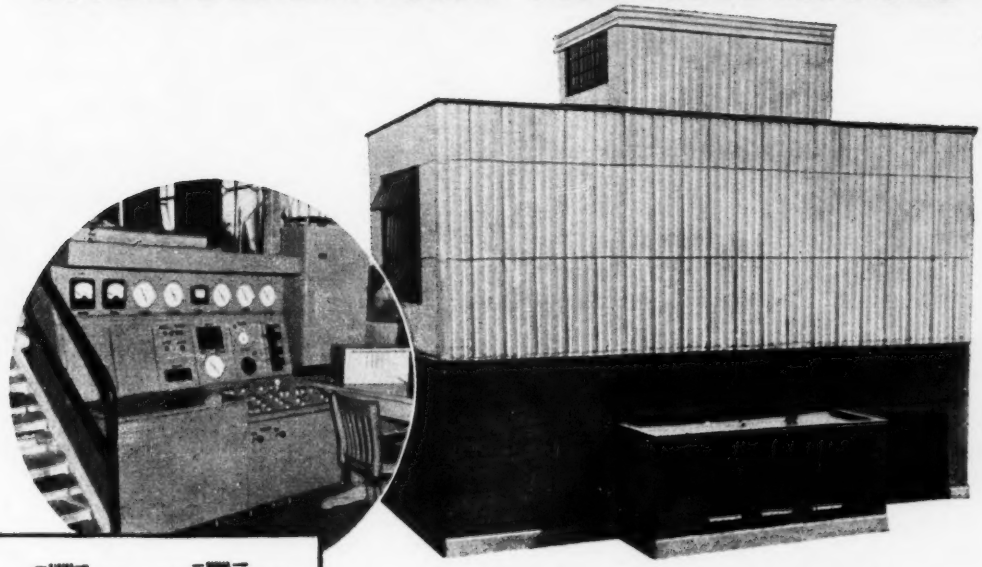

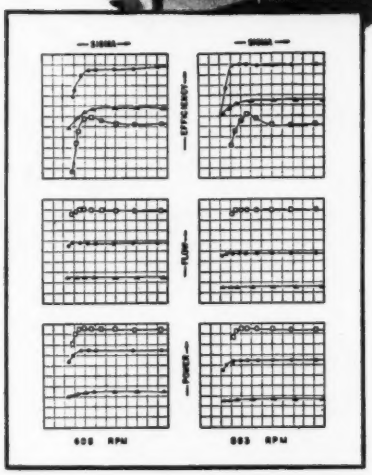

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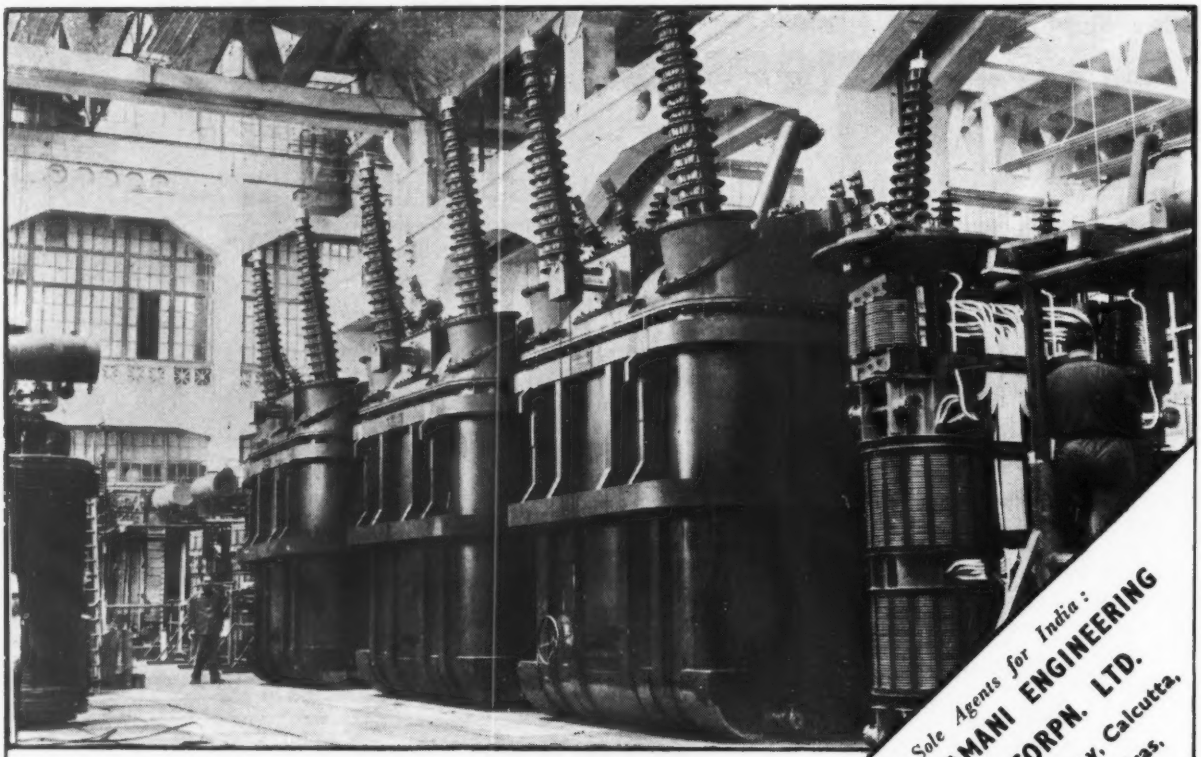

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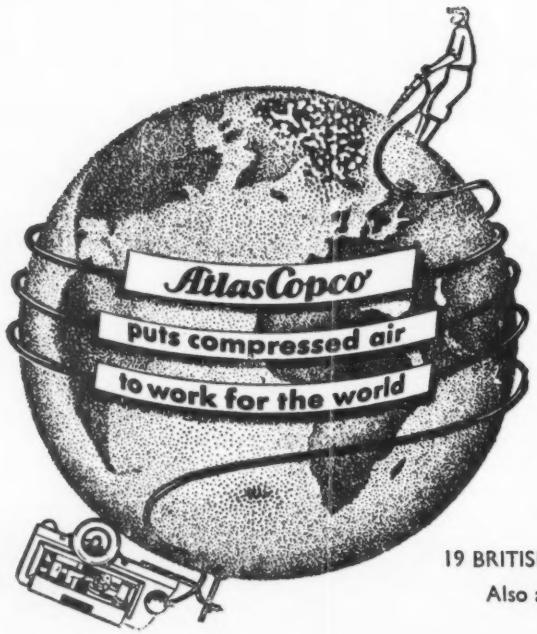

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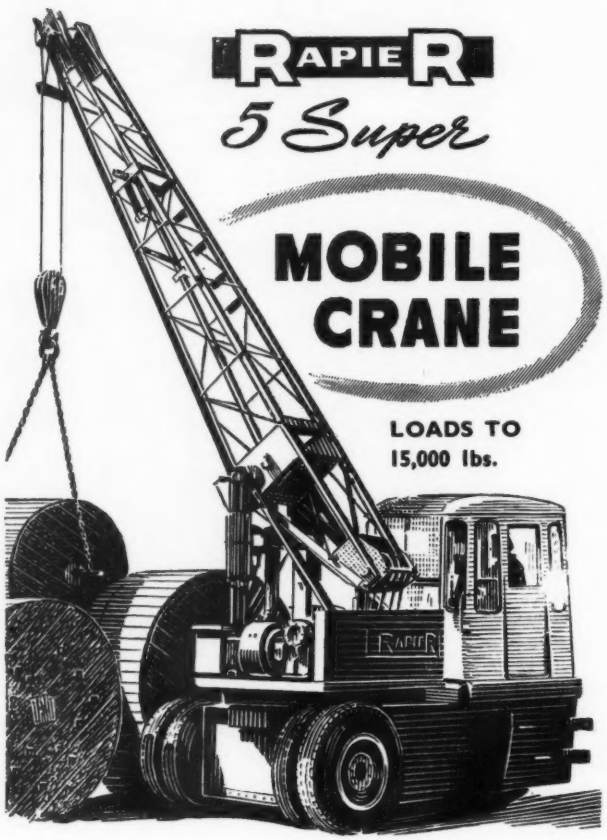

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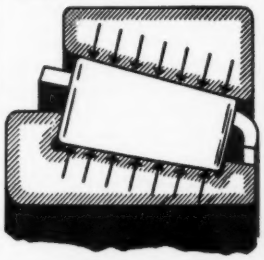

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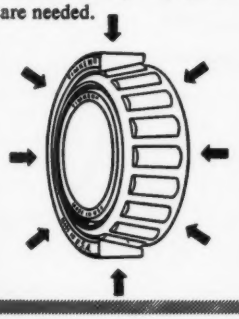

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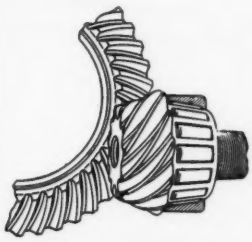
Timken bearings hold shafts in positive alignment, prevent end-movement, minimize deflection. Gears mesh precisely, assuring a smooth flow of power.



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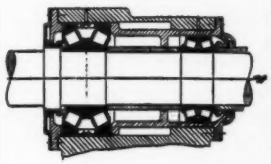

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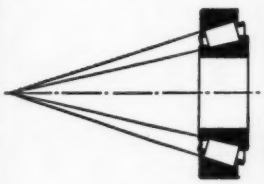
Timken bearings roll freely due to true rolling motion. Lines coincident with the tapered surfaces of rollers and races meet at a common point on the bearing's axis.



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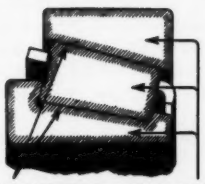

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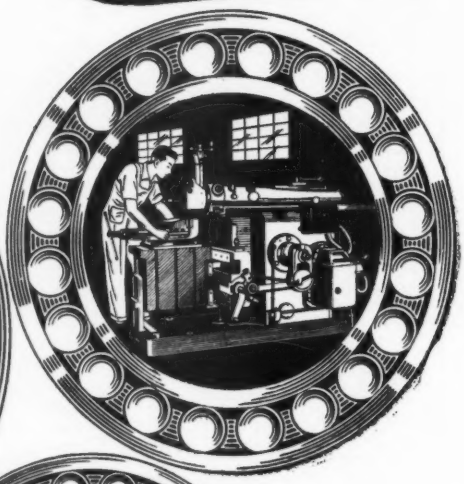

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Steam Turbines

By

SIR CLAUDE D. GIBB, K.B.E., D.Sc., F.R.S.

Chairman and Managing Director of C.A. Parsons & Co., Ltd.

AUTHOR

Electricity is so much an essential part of our every day life to-day, that it is difficult to realise that only sixty years ago electricity was little more than a new toy in our homes and offices, and was only beginning to make an impact upon industry. Sixty years of almost completely unbroken development in the use of electricity have taken place and, with it, a corresponding improvement in our standards of living. A study of the major nations of the world shows that a high living standard is always associated with a correspondingly high consumption of electricity per head of population, both in industry and in the home.

The widespread use of electricity has been made possible almost entirely by the developments in output and efficiency of the steam turbine. Less than ten per cent of the electricity of the world is developed by water power and over eighty per cent by steam turbine driven generators. The size of steam turbines has grown from a mere 10 horse power to over 400,000 horse power in the short space of 71 years.

The first known mention of a steam turbine was over two thousand years ago, when in 55 B.C. Hero of Alexandria described his Aeropile, which was a true reaction turbine. A steam turbine is a special form of engine, which, because it has no piston or other reciprocating parts but develops its power with direct rotary motion, is the ideal prime mover for driving large electrical generators. The turbine has a further big advantage in its ability to make full use of high vacuum and thereby to operate at higher efficiency than a reciprocating engine.

Although the steam turbine was first described two thousand years ago, it does not appear to have been considered seriously until 1629 when Giovanni Branca depicted in a fairly detailed drawing what to-day would be called an impulse turbine. From then onwards for another two hundred years, many engineers and scientists experimented with turbines, but none were practical engines until 1884 when Parsons produced a pressure compounded turbine of 10 electrical horse power which ran at 18,000 revolutions per minute. From that year onwards the rate of development of the steam turbine can only be described as phenomenal.

Charles Algernon Parsons was a son of a famous scientist and had a scientific training at home and at the Universities of Dublin and Cambridge. His scientific background made him realise that to attempt to take the full pressure drop from boiler to atmosphere in one stage of blading would involve such high rotational speeds as to be mechanically impossible. He therefore designed his first turbine with a number of pairs of blades through which the steam passed in series from boiler pressure to atmosphere. This he called his pressure compounded turbine and it is this principle which is used universally to-day in all modern steam turbines of large outputs.

For the first seven years after the successful turbine of 1884, boiler pressures were only between 50 and 100 pounds per square inch and all exhausted at atmospheric pressure. During those seven years, outputs rose from 10 to 100 horsepower, but in 1891 Parsons built the first condensing turbine of 100 kilo Watts, or 140 horse power output, and this machine was found to have a steam consumption per unit of power lower than the best reciprocating steam engine of the day. That turbine, installed at Cambridge, England, was the turning point in the acceptance of the turbine as the prime mover of the future wherever large powers were required. In a short seven years, the steam turbine had equalled the effiiciency of the reciprocating steam engine in its evolution over a hundred years. Truly a remarkable achievement.

By 1900, units of 1250 k.W. had been built, by 1913 output was to up 25,000 k.W., by 1923 it was 50,000 k.W., and efficiencies had advanced with outputs until coal consumption was halved and halved again as pressures and temperatures increased with outputs and scientific research was applied to blading design.

To-day, units of over 400,000 horse power are under construction, and one steam turbine is being designed for a steam pressure of 5,000 pounds per square inch.

Steam temperatures have risen from a mere 300° Fahrenheit to 1100° or approaching a dull red heat. The higher the pressure and temperature at the inlet to the steam turbine, the higher should be the efficiency. But it is temperature, more than pressure, that provides difficulties in operation, and if pressure is increased faster than temperature then the steam becomes too wet in the low pressure region of the turbine and trouble due to water erosion can be seri-

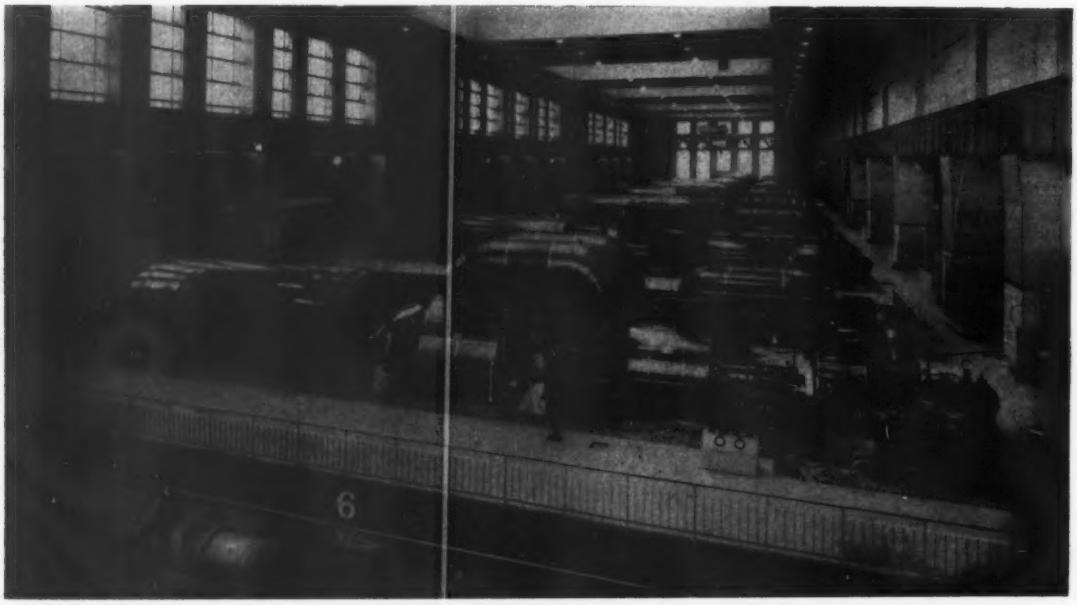
A photograph showing four 20 mW Parsons Turbo Generators installed in Connaught Bridge Power Station, Malaya

A photograph showing four Parsons Turbo Blowers installed at the Steel Works of the Appleby: Frodingham Steel Co., England.

A photograph showing one of two 30 mW Parsons Turbo Generators installed in the Belfast West Power Station, Northern Ireland.

ous. To overcome this and to enable still higher efficiencies to be obtained, the steam direct from the boiler is partially expanded in the turbine and then extracted, returned to the boiler for reheating in a secondary superheater, and again introduced to the turbine where it continues its expansion and work development down to condenser or vacuum pressure. Where the steam pressure is exceptionally high—

A photograph showing one 50 mW and two 30 mW Parsons Turbo Generators in New Cossipore Generating Station, Calcutta.

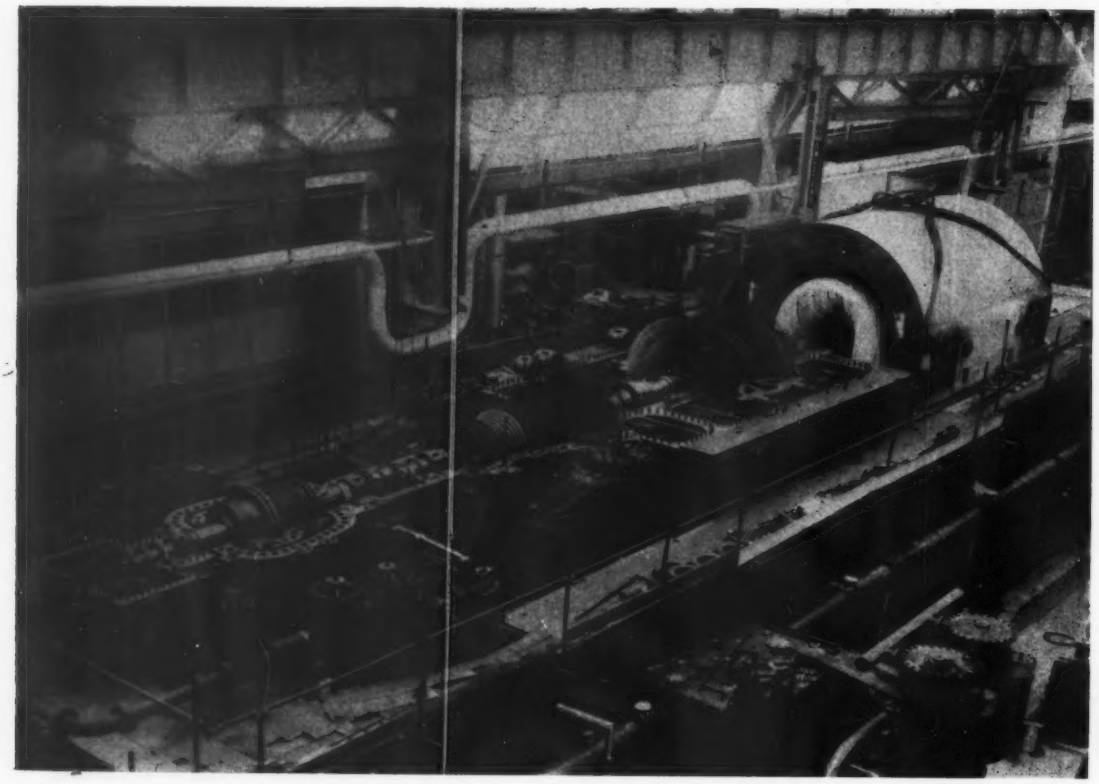


A photograph showing six 60 mW Parsons Turbo Generators in the Keadby Generating Station of the Central Electricity Authority, England.

generally when pressure is above the critical pressure of 3,250 pounds per square inch—the reheating of the steam may be done twice. This is known as two stage reheating.

In any simple condensing steam turbine, something like three-quarters of the potentially useful heat in the steam is lost in the condenser when the latent heat or the heat of evaporation or condensa-

A photograph showing a 100 mW Turbo Generator for operating conditions of 1,500 lbs. per sq. in., 975°F, reheat to 950°F under construction at Heaton Works of C. A. Parsons & Co. Ltd.



COVER ILLUSTRATION

The Skelton Grange "A" power station of the Central Electricity Authority, Yorkshire Division contains six 60 MW Parsons turbo-generators comprising three cylinder all reaction type turbines coupled to hydrogen cooled generators which operate with steam at a pressure of 900 lbs. per sq. in. gauge and a temperature of 925°F.

During the week ending December 9, 1955, Skelton Grange power station generated 50,436,200 units on the five turbo-alternators then installed. This is equivalent to a generating plant load factor of over 100% which means that the machines carried a little over full load for the whole of seven days and nights. Plant load factors of over 100% have been attained before, but usually on smaller sets in smaller stations. It is very doubtful whether a load factor of 100% has ever before been associated with an output of over 50 million units.

No. 6 alternator was synchronised for the first time on December 14, 1955, and then more records were achieved.

During the week ending January 6, 1956, 58,078,300 units were generated. This is the greatest output ever produced by a single power station in the U.K., and was a record at that time. Since then, however, Skelton has twice beaten its own record, 59,346,700 units being generated during the week ending January 20 and 59,629,400 (56,478,600 sent out) in the week ending January 27, equivalent to a load factor, on a sent-out basis, of 100.05%.

Whilst producing its record output Skelton Grange retained its position as the station with the lowest fuel cost in the country per unit sent out. In order to produce the 59,629,400 units, no fewer than 28,983 tons of coal were consumed which included 5,746 tons of fines, dusts and slurry and 2,808 tons of opencast. The average calorific value was 10,132 B.Th.U.s/lb. and the overall thermal efficiency of the station was 29.28%."

tion is given up to the cooling water as the exhaust steam is converted to water ready for pumping back to the boiler. This water or condensate is at a relatively low temperature and if put direct into a modern boiler would cause trouble by chilling and sweating. The boiler wants hot water fed to it thus to avoid trouble and also to save fuel, and, fortunately, the turbine would like less steam passing to the condenser. Hence, steam, after doing most of its potential work in the turbine, is extracted and put into feed water heaters which are small condensers having as cooling water the condensate from the main condenser. If the steam is tapped off at varying pressures above exhaust pressure and the condensate is passed through a number of heaters in series on its way to the boiler, the maximum combined efficiency of turbine and boiler can be reached. Depending upon the steam pressure at the turbine inlet valve, there may be from four to nine stages of feed water heating. The total amount of steam tapped off may reach over thirty per cent of that initially entering the turbine and thus the latent heat of that amount of steam is saved for the boiler instead of being wasted in the cooling water from river, sea, or cooling tower to atmosphere.

Efficiencies have increased in seventy years from about 5 per cent to over 40 per cent. One unit of electricity is now generated by less than one pound of coal, whereas the earlier turbines required more than twenty pounds of coal per unit.

In these developments many famous engineers have played a great part. Parsons in England, Rateau in France, Curtiss in America—each contributed much and were pioneers. Their work is carried on to-day by teams of specialists in aerodynamics, thermodynamics, mathematics, metallurgy and the other many branches of modern and complex engineering.

Metallurgy has played a major part in the development and growth of the steam turbine. Improved materials had to be produced and tested to enable higher pressures and temperatures and higher stresses to be employed. Exhaust blade tip speeds of over 1500 feet per second are now being used with stresses that would have made our fathers' hair stand on end—and sometimes makes ours do just that also. The modern steam turbine is an exceedingly complex and highly stressed engine calling for great experience and skill in its design and manufacture.

Just what does a modern large steam turbine look like ? Let us take a size of unit that is neither the largest nor the smallest, but one which is being built in Britain in quite large numbers. Its output is say 120,000 k.W., or 160,000 horse power. That is, its power is equal to some 8,000 family size motor cars all connected together on one shaft. The overall length of that turbine will be about 66 feet with a width of 12 feet. Generally, it will have three cylinders—a high pressure, an intermediate and a low pressure. Steam from its boiler will be at a pressure of 1,500 pounds per square inch and a temperature of 1,050° Fahrenheit. At this pressure, the steam first passes through a steam chest in which are governor valves to control the amount of steam admitted to the turbine. The governor valves are automatically opened or closed according to the load placed on the electrical generator, and at all loads, the speed of the turbine is maintained constant at normal frequency speed. So accurately is speed controlled, that electric clocks, operated from the steam turbine driven

generator, will be accurate to within a few a seconds at any period of the day or year.

After passing the governor valves, the steam enters the high pressure turbine, and passing through nozzles and blades, begins to fall in pressure and temperature and in so doing increases in velocity and is changed in direction. A modern windmill is something we all know, where air flowing upon shaped blades causes them to rotate. A steam turbine is a very scientific high pressure windmill. The steam, in passing through blades of aerofoil shape attached to a shaft, rotates the shaft and in passing through row after row of blades each one a little bigger in area than the preceding row adds more power to the shaft. The reason for the increase in blade area is that as the steam pressure falls, it expands and occupies a greater volume per pound.

In the high pressure turbine, the steam would fall in pressure to about 400 pounds per square inch and then, on leaving the cylinder, would be returned to the boiler for reheating to 1,000°F. before entering the intermediate cylinder to begin developing more power by passing through more blades. In this cylinder the pressure would fall to about 60 pounds per square inch and then, by large diameter pipes, pass to the low pressure cylinder. In large output turbines it is almost universal practice to divide the steam in the low pressure cylinder and to have two sets of blading mounted on the shaft, each taking half the steam in its passage to the condenser where the pressure is between $\frac{3}{4}$ and $\frac{1}{2}$ pound per square inch absolute. The volume of the steam per pound at the entry to the condenser will be over one thousand times as great as that same steam entering the high pressure cylinder. This large volume demands very large blading areas and provides one of the most difficult design problems in the whole turbine. Blade tip speeds exceeding one thousand miles an hour are now being used and, unlike an aeroplane which only reaches the velocity of sound for a very short period and then only infrequently, turbine blades must operate continuously at their full speed for some 8,000 hours each year and go on doing that for at least 25 years. Stresses of 18 and 20 tons per square inch are commonplace in exhaust blades and discs, and only the vast sums of money spent each year in research have made such developments possible.

To obtain high efficiency in a turbine, the high pressure blades must have a reasonable area and this means that there must be a maximum volume of steam passing through them. Turbine output is approximately proportional to the weight of steam passing per minute and steam volume is proportional to steam pressure. Hence there is a definite efficiency limit to the pressure which can be adopted and pressures can only increase as outputs are increased. This has led to standard pressures for standard outputs. Thus, for 30,000 k.W., the standard steam pressur is 600 pounds. For 60,000 k.W. it is 900 pounds. For 120,000 k.W. it is 1,500 pounds and for 200,000 k.W. it is 2,350 pounds per square inch.

There is no form of prime mover which has a record of reliability and efficiency better than the steam turbine. It is the evolution and development of a British invention and in the nuclear or atomic age into which we are moving will still remain the actual source of power. There is no indication that any other form of mechanical power unit is in sight likely to replace or seriously challenge the steam turbine

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Recent orders received by C.A. Parsons include 200 MW machines for Toronto, Canada, and for the C.E.A., Great Britain. The Toronto, machine will be cross-compounded with operating conditions of 1,800 lbs. per sq. in. 1,000°F, reheat to 1000°F. The single line machine for the C.E.A. will operate under steam conditions of 2,350 lbs. per sq. in. 1,050°F with reheat to 1,000° F.

Our Valley Projects: Some Observations

AUTHOR

By

C. L. HANDA, I.S.E.

Director, Bhakhra Dam Designs Directorate

River Valley Development programme has been a prominent feature of our national endeavour now for some time ; and it is bound to maintain its share of significance even for some more years in the future. The experience so far gained should enable us to reflect on our efforts confidently, though not complacently, and to draw some broad lessons for future guidance. Also, the work in hand has given quite a large number of Indian engineers a rare opportunity of visiting foreign countries and of having a view of the methods and techniques employed in valley development. This should also help us to take a more modern and upto-date view of our problems and tasks. As one of such engineers, I take the liberty of making a few suggestions and comments on our valley projects, with the hope that these will be found worth serious consideration.

Project planning needs to be instituted, both in the States, as well as in the Centre, as a compulsory activity which should go on continuously.

There ought to be specific budget provision in the allotment of funds to the irrigation and power departments under which it should be possible to engage on necessary investigations of the reconnaissance type without having to go back to Government for specific sanction in each case. Finance should bless a scheme once for all in the beginning and thereafter let it continues upto the authorized ceilings without new sanctions for details.

The amount of money needed for each reconnaissance investigation will be a function of the requirements of the special project or group of projects. To some extent it will be a function of the agency and the extent and scope of the needs of the region which have to be fulfilled. The integration of the particular project with other projects already completed or to be undertaken is essential and would be taken care of in the reconnaissance investigation.

The collection and compilation of available data regarding discharges, water studies, and power studies would be an essential part of the investigation. The use of water resources will be studied for meeting the needs of irigation, power and other facilities in an integrated manner.

For the implementation of the reconnaissance investigation, use would have to be made of the most experienced staff who are concerned with the problems. It will not serve any useful purpose if novices are put on the job without adequate guidance from experienced personnel. Usually, the mistakes that are made in the conception and outline of a project are made at the very beginning, and later on they become difficult to correct. Due to this reason, the key personnel working in any State or region will necessarily be coopted in the investigations. They will be supplemented by experts selected from the central organization or from any consulting group or individual consultant.

There is obvious need in India for the elimination and reduction of waste of money, time, personnel, and resources. Also, the projects to be recommended for authorization should be such that they do not leave any room for uncertainty regarding the returns which will make the investigation productive.

At present there is the inevitable lack of coheson and coordination which generally attends activities at the time of their first expansion. In the case of the Centre and the States, the expansion of the development programs is so great that it has far outstretched the available personnel or data. Yet the effort has to be for bringing the expansion within the control of the resources of our organizations and personnel. It is with a veiw to help in this objective that this article has been written for the Indian Journal of Power and River Valley Development, who are pioneers in this field.

It is essential for a proper and efficient development policy that we may make as little resort to the hit--and-miss methods that we have to use now. Lack of continuity and mere drifting have to be replaced by proper planning, including realistic schedules for the time required for the various stages of the whole project. The older and senior engineers who have valuable experience must be drawn upon for the benefit of their mature judgment, although they may not be in the line organization. The younger engineers should furnish the necessary drive and initiative, and they should shoulder the strenuous field programs of investigations which will make our projects more positive and less liable to be underestimated in cost or in the period of completion.

Reconnaissance Investigations

Some short-cut methods need to be introduced

if the "*reconnaissance investigations*" are to be completed within a reasonable time and without keeping the concerned public, Government, or the political leaders too long in suspense. For this reason the examination regarding the feasibility of a project needs to be arranged and completed within a well-defined time limit so that on the one hand a realistic and approximately cost accurate figure may be obtained, and on the other, there should be less waiting for more and more reviews and examinations, which keep the end results in doubt.

The money that would be required for such investigations would be only a small fraction of the savings obtained by a timely disclosure of the defects of some of the projects which though sponsored enthusiastically by vested interests, do not have the potentiality of standing the test of technical criteria. At the same time projects which are of real benefit will be sorted out quickly and can be pursued with vigor. Once the feasibility has been correctly appraised, it will be a question of putting up the necessary funds, and of the appropriate organization to accomplish the execution of various stages of the projects.

In order to get the best results in the face of the current difficulties of shortage of really good men, it is important that a pooling of the experience and know-how of seasoned engineers may be secured. Not only should we aim to recruit the large number of fresh hands required, but the more important things is to insure that men of the right quality, experience, and aptitude are collected to form the nucleus of the team.

Some Difficulties

Some of the difficulties with which we are now faced are discussed below:

(*a*) The cost of projects as given out to Government is repeatedly exceeded, and revised estimates become necessary. The amount of additional expenditure demanded is sometimes as much as 50 percent or even 100 percent of the figures originally quoted. This naturally does not add to the prestige of the engineering profession.

(*b*) The time in which it is originally claimed that any project will be completed is generally exceeded. Programs set out for 3 years take 6 to 7 years, and those set out for 5 years take 10 to 15 years. This is hardly planning. The man in the street or in the village is not inspired by such deviation from promised dates.

(*c*) The mechanical construction equipment is difficult to obtain. Also it is not selected after over-all planning, but purchased in a piecemeal fashion. As such, it does not make a proper complement which will do a job, but additional units and changes are continually necessary. Improvisations are good, but no plan can properly be based on improvisations alone.

In the same category may be mentioned the difficulty about the lack of repairs and spares for equipment on various projects. The pooling of equipment and the quick mobilization of the necessary accessories and men from one project to the other is a vital necessity. This matter has been discussed times without number, but a real start cannot be said to have been made.

(*d*) One of the main difficulties is about the lack of proper data on the current projects. It is always difficult to know, readily, what the costs of various items are. The information is not handy and takes a lot of time to collect. Yet there are various organizations in India who are in possession of reliable data, and all that is needed, is the machinery for quick collection and compilation. Personal contacts of the requisite frequency and enthusiasm are lacking. There is generally some hesitation in sending engineers from headquarters out to the field, and vice versa, for the pooling of such data and experience.

Possible Remedies

In order to suggest remedies for some of these difficulties and to indicate a procedure for the right approach, advantage has been taken by me of the procedures as are adopted in the United States. No doubt, the requirements of land reclamation and power programmes of the U.S.A. differ widely from those in India, but there is a lot in common from which we can benefit.

With this end in view, the following suggestions are offered for stirring up thought and discussions by which we may determine what is best suited to the needs and climate of our country so that the goal of speedy development may be fulfilled.

The objectives which India has in view at this time in the matter of Irrigation and Power Projects can be summed up as follows:

A greater and speedier out turn is needed in the fields of planning, design, and construction, even though there is no way that the staff can be increased in step and in proportion with the expansion of programmes.

A bigger achievement needs to be obtained with relatively smaller expenditures. This can be secured, first, by avoiding wastes, and second, by the more efficient use of available resources in men, materials, and money.

The completion of projects in the Five Year Plans needs to be further speeded up in spite of the shortage of staff, data, and funds. This would, literally speaking, be a miracle. But such miracles can be wrougt by studying the know-how of more advanced countries and the manner in which they have corrected their mistakes and developed new techniques.

Like the Engineering Seminars lately arranged by the Irrigation and Power Ministry, we need to push forward the processes of deliberation to a large-number of forums. It appears necessary that cells and panels of experts be created, for adhoc consultations, by calling forth from the States, some of the engineers who have had the opportunity of participating in big projects, whether in the design or construction fields. The formulation of direction of such programmes needs to be undertaken by the Centre, in a vigorous manner. The Centre should have the authority to call for data from the States and also to call for the experts from the States to participate in specially arranged programs of review and consultations. Only in this manner will there be the necessary mobilization of forces for the handling of designs, research, and other technical data. Reliable shortcuts should be evolved to expe-

dite decisions. These can help to achieve the end-results without having to wait for too many drastic changes in the present organizations at the Centre or in the States.

There are quite a few bottlenecks and handicaps which attend the planning, design, and execution of projects in India, which can be more speedily resolved if the above suggestions are followed

Constructive approach: need of the Hour

One could draw up a long list if one chose to catalogue all the holdups or wastes. But less is gained by destructive criticism than by constructive suggestions.

This note is based on a keynote of construction derived from the experience and know-how of the world's big organizations in the field of design and construction of irrigation and power projects. At one time or other, in their own evolution, these bodies have faced and successfully overcome the hurdles, with which we are now confronted. To summarise, our chief hurdles are as follows:

(*i*) Planning is incomplete and fractional. We generally proceed from a part to the whole, with the inevitable liability to greater mistakes.

(*ii*) Our designs are not ready sufficiently in advance Alternatives which are possible for various features of a project need a lot of time for their study. We are generally always rushed for time after a project is authorized, and have thus no opportunity to study in sufficient detail the various alternatives that are possible.

(*iii*) In order to have basin-wide planning and an integrated picture for the development of the use of water for irrigation, power and other purposes, we need to have a closer liaison with the Geological Survey of India, Agricultural and Food Departments, and the Departments of Industries in the States as well as in the Centre.

To a large extent this is being achieved by the Planning Commission, but it is the function of the engineers in charge of specific projects to bring out the technical inter-relationship of various projects that is essential for over-all development.

(*iv*) Engineering is a dynamic science, and it is predicated on introducing changes whenever improvements can be effected. In India some of our techniques are not abreast of the modern practice. However, we cannot afford to remain behind or out-of-step. For this purpose, we have to deliberately get out of old grooves and give every encouragement for progressive thinking. It remains important that any changes accepted should be suitable for being dovetailed into our economy. This can only be feasible when the data have been studied and thrashed out. Thereafter, we should not hesitate and should be entirely ready to follow the good practices which have been evolved by some of the more progressive organizations, like the Bureau of Reclamation, U.S.A., and go ahead with improvements in the pursuit of better technology, which alone can solve the problems of India's want and poverty.

One factor that needs to be kept prominently in view is the outright importance of engineers keeping abreast of the progress and development in engineering science. Every year (almost every week) some important discovery is being made in the realm of engineering design, construction, or research. Fresh attacks on old problems are yielding rich results. Such knowledge is usually not found in text books but has to be obtained by assiduous attention to engineering journals, periodicals, and deliberations of institutions like the American Society of Civil Engineers, Institution of Civil Engineers, London, and a large number of other associations. The belonging to these bodies by individual engineers is a matter that is beyond the pocket of many of those who ought to derive benefit from such institutions. It is important that Government encourage the membership of such bodies to be extended to institutions so that they can meet the subscriptions and other expenditures without being a burden on any one individual. The advantage of such belonging and further participation in the deliberations of such institutions will be immense and far out of proportion to the small sums involved.

This is an important aspect of engineers identifying themselves with such know-how in the profession. In progressive countries, conventions of technical bodies are becoming increasingly popular, and India should follow the same pattern.

(*Continued from page* 16)

Atomic Energy Development in India

cal Assistance agreement was also signed with U.S.A. for the supply of nuclear research equipment and apparatus.

As regards building up the Atomic Energy Establishment in India, the training facilities offered by U.K. and U.S.A. and other countries in the field of nuclear science, engineering and reactor technology are being taken advantage of. During the year under report, three Indian scientists attended the Reactor School at Harwell. One scientist attended the Nuclear Engineering Course at the Argonne National Laboratory, U.S.A. Three scientists attended the Radio-isotope Course at Oak Ridge. Certain other scientists worked at the Laboratories of the Commissariat a l'Energie Atomique of France.

Determination of the effect of Sluicing on Deposition

By

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The effect of sluicing on deposition has been studied from the sluicing closure data observed at Madhopur Headworks on the River Ravi in Punjab (India). This method of washing away the shingle accumulated in the pocket and the approach has been in practice at this headworks since 1938. The data collected during sluicing closure period consist of ramp and shingle observations in front of all the bays of the Head Regulator together with the order in which undersluice gates are opened. The depoists in the pocket accelerates the entry of shingle and silt in the canal, and thus this method provides an immediate relief to the silt trouble in the canal. Whenever the depth of ramp (measured from the cill level) in the pocket falls within two feet or so, undersluice gates are opened to wash away this deposit. The duration and frequency of the closure depend mostly on the river conditions which are promptly determined by the staff stationed at Headworks.

Rate of Ramp formation between successive closures

The rate of ramp formation between two successive closures has been determined in a number of cases by plotting values of ramp against the corresponding days, and then fixing a suitable mathematical relation between these. The analysis showed that the value on the day next to the sluicing closure day did not fit in with the other values and as such needed separate consideration. These values are given in Table I and have been expressed as percentages of the values observed after sluicing closures. River gauge and discharge are also noted against these.

A perusal of the Table I shows that these values have recorded a decrease from 20% to 50% in a single day depending mainly upon the discharge in the river. In most cases a falling river is responsible for heavy deposition in the pocket in front of the cill of th canal regulator, while in case of a rising river, ramp formation is proportionally low. Some other factors which cause heavy deposition are :

(*i*) Season of the year
(*ii*) Source from which the river is fed
(*iii*) Slope of the river

Relation of the type $Y = aX$ plus b (St. Line)
Where X = number of days beginning from the second day after the sluicing closure day
and Y = Depth of ramp in feet

and has been found to fit very well with the rest of the values. Half a dozen sets have been considered. Lines drawn are shown in *Figs. I to VI.*

The calculated values have been compared with the actuals and are given in Table II for comparison. Difference between these has been noticed as negligible

Now $Y = aX + b$

Differentiating Y with respect to X, we have

$$\frac{dy}{dx} = a = \text{constant.}$$

This shows that ramp forms in the pocket at a constant rate.

Frequency and Duration of Sluicing closure

The frequency of a sluicing closure depend mostly on the river conditions. Whenever the depth of ramp below the advanced crest falls short by a certain minimum value (to be fixed locally) sluicing closure is considered necessary to check excessive shingle and silt entry into the canal. Sluicing closure is also considered necessary if the river gauge crosses a certain limit. In case of Madhopur Headworks, these limits are respectively 2 feet and 12 feet. It is observed that in case of a rising river, the interval between two successive closures is shorter than in case of a falling river.

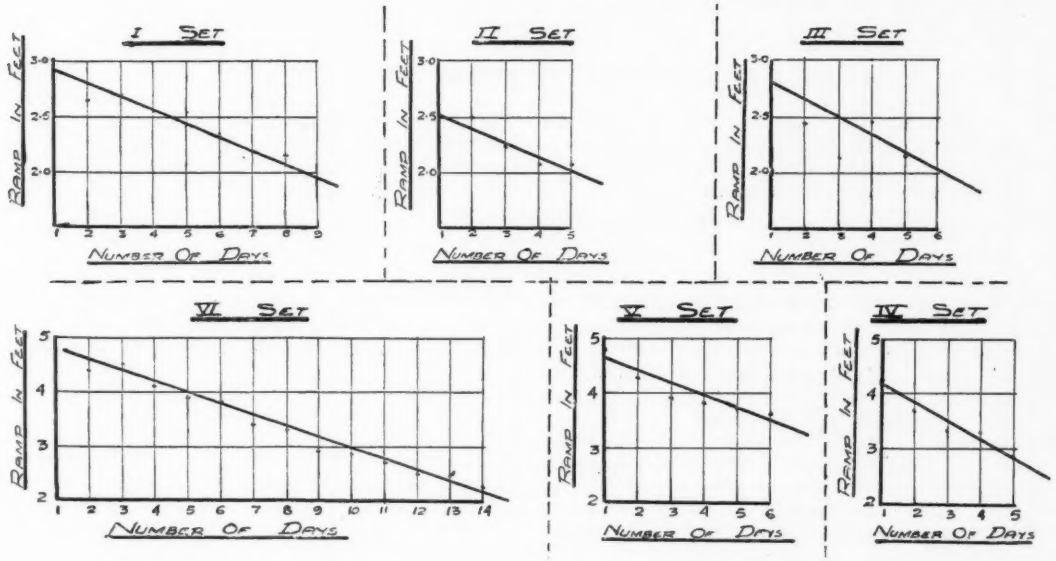
The duration of a sluicing closure should be minimum possible. As is evident from Fig. VII, a sluicing closure of 20 to 30 minutes duration is effective, and a longer period generally serves no useful purpose, more so in case of a rising river.

Duration of each closure together with ramp values before and after closure are given in Table III.

Effect of deposition on the entry of coarse silt in the Canal

In order to determine the effect of deposition on the entry of coarse silt in the canal, values of the latter were plottd against the former. The points were all scattered and hence no relation could be found out. This shows that a heavy deposit in the pocket is not always likely to be followed by heavy entry of coarse silt in the canal. This mainly depends upon the source from which the river is being fed.

SHOWING STRAIGHT LINES FITTED TO THE VALUES OF RAMP OBSERVED BETWEEN TWO SUCCESSIVE CLOSURES. (SLUICING CLOSURE DAY & THE FOLLOWING DAY EXCLUDED)



Effect of Sluicing on Deposition

Before the introduction of sluicing closure at Madhopur in the year 1938, big boulders right up to the diameter from 12″ to 13″ were entering the canal. Various devices, such as a cantilever platform, shingle excluder etc. were suggested to check this menace. Sluicing closure was finally adopted as an immediate measure and is still practised.

The closures were found to be very effective in reducing the depth of shingle ramp in grade and quantity of shingle and coarse silt entering the canal. Shingle is reduced to nil while coarse silt is reduced sufficiently.

Although sluicing is effective in reducing the depth of shingle ramp in front of the advanced crest of the cill level, yet its effects are not lasting. Ramp forms rapidly immediately after the sluicing closure, and this necessitates another closure after a week if not earlier. It has been observed that during monsoon when coarse silt and shingle are heavy, closures become more frequent This frequency of sluicing closures sometimes causes unusual deposit upstream of the pocket.

Conclusions

The following conslusions are drawn :

(*i*) Immediately after the sluicing closures, depth of ramp (below cill level) decreases from 20% to 50% in a single day, depending upon the discharge of the river.

(*ii*) Thereafter, rate of ramp formation is more or less uniform.

(*iii*) A sluicing closure of 20 to 30 minutes duration is effective, and a.longer period generally serves no useful purpose, more so in case of a rising river.

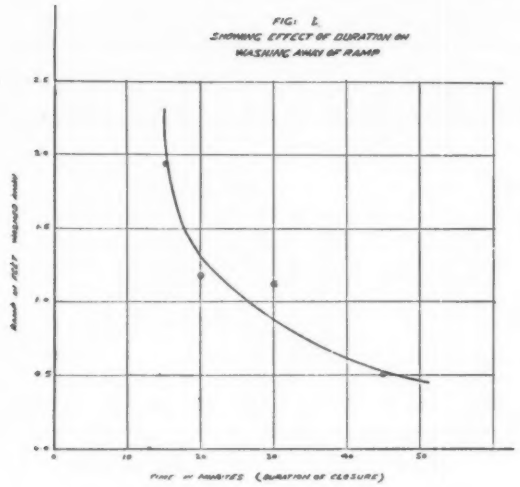
(*iv*) Entry of coarse silt in the canal has no relation with deposit in the pocket.

(*v*) Effects of sluicing closures are not lasting and their frequency sometimes results in an unusual deposit upstream of the pocket.

Table I

Showing values of ramp on the sluicing closure day and the following day along with the respective discharges.

	(River Ravi at Madhopur)		
Date	Discharge in cusecs.	Ramp in feet	Percentage
25.5.50	14880	4.10	70.73
26.5.50	14880	2.90	—
6.6.50	10900	3.18	82.08
7.6.50	10900	2.61	—
11.6.50	18760	4.50	51.56
11.6.50	15850	2.32	—
13.6.50	24048	4.25	79.53
13.6.50	17230	3.38	—
16.6.50	24572	4.79	54.28
17.6.50	25596	2.60	—
20.6.50	21940	4.50	60.00
20.6.50	21410	2.70	—
24.6.50	17230	4.10	60.98
24.6.50	15820	2.50	—
28.6.50	19025	4.56	46.93
28.6.50	14410	2.16	—
30.6.50	19210	4.58	54.59
30.6.50	16760	2.50	—
8.7.50	18760	4.80	54.17



8.7.50	21410	2.60	—
10.7.50	20550	4.34	62.21
11.7.50	20350	2.20	—
17.7.50	21940	4.87	64.89
17.7.50	21940	3.16	—

Table II

Statement showing the observed and the calculated values of shingle ramp during successive closures (River Ravi at Madhopur)

First Set :

Values observed.	Values calculated from relation Y = 2.97026—0·10783x)
2.90	2.86
2.62	2.75
2.69	2.65
2.53	2.54
2.52	2.43
2.35	2.32
2.19	2.22
2.15	2.11
1.93	2.00

Second Set :

Values Observed.	*Values calculated* (Y = 2.65600-0.12600x)
2.50	2.53
2.50	2.40
2.23	2.28
2.08	2.15
2.08	2.03

Third Set :

Values observed	*Values calculated* (Y = 2.69202—0.04629x)
2.70	2.65
2.44	2.60
2.13	2.55
2.48	2.51
2.15	2.46
2.28	2.41

Fourth Set :

Values observed	*Values calculated* Y = 4.313-0.277x)
4.21	4.04
3.70	3.76
3.35	3.48
3.35	2.21
2.80	2.93

Fifth Set :

Values observed	*Values Calculated*
4.89	4.64
4.29	4.41
3.97	4.18
3.86	3.95
3.71	3.72
3.65	3.49

Sixth Set :

Values observed	*Values calculated* (Y = 5.01278—0.20818x)
5.20	4.80
5.41	4.60
4.45	4.39
4.12	4.18
3.89	3.97
3.80	3.76
3.38	3.56
3.31	3.35
2.92	3.14
2.88	2.93
2.34	2.72
2.53	2.51
2.44	2.31
2.25	2.10

Statement showing date and duration of closure along with ramp values before and after

(River Ravi At Madhopur)

Date	*Duration (In Minutes).*	*Depth of Shingle Ramp in Feet Before closure*	*After closure*
1.5.39	30	3.7	5.0
2.5.39	30	3.8	5.0
3.5.39	30	3.6	4.7
4.5.39	30	4.0	5.0
5.5.39	30	3.7	4.8
8.5.39	20	4.6	5.7
9.5.39	20	4.6	6.3
10.5.39	20	4.1	5.6
11.5.39	20	3.0	5.6
16.5.39	15	3.9	5.8
20.5.39	20	4.5	6.0
25.5.39	20	4.7	6.3
1.6.39	20	5.4	6.2
26.6.39	20	4.0	6.1
7.7.39	20	4.8	5.9
14.7.39	20	5.0	5.8
1.8.39	30	4.0	5.3
5.8.39	30	4.5	5.2
13.8.39	30	4.2	6.2
18.8.39	30	5.0	5.8
25.8.39	45	4.4	4.9
28.8.39	30	4.4	5.8

Atomic Energy Development in India

By

DEPARTMENT OF ATOMIC ENERGY, GOVT. OF INDIA

It is needless to mention that potentialities of atomic energy are great in India. Compared to other Asiatic countries quite a good deal of work has been done in this country, thus providing for the creation of a cadre of trained personnel vitally necessary in the task. Only this month a Swimming-pool Reactor was set in operation. The following account of the work done by the Department will be read with great interest.

This note gives a brief account of the work done by the Department and its attached organisations during the current year and work proposed for the coming year.

Atomic Energy Establishment

On the recommendation of the Atomic Energy Commission, an Atonic Energy Establishment has been set up. An area of about 1,100 acres is under acquisition in Trombay, 13 miles off Bombay. Out of this area, 805 acres have already been acquired. The site is unique. One side is on the harbour and has two piers, one of which has already been developed for landing machinery, materials, etc. The site is out off from the neighbouring lands on all the other sides by a hill range. It is, therefore, isolated and at the same time easily accessible. Foreign experts, who have visited the site, have commented on its uniqueness and suitability for the purpose of locating the atomic reactors as well as research laboratories, uranium and thorium plants, etc.

The Trombay Planning Committee entrusted with the planning of the Atomic Energy Establishment submitted its report during 1955, which has been accepted by the Atomic Energy Commission and the Government. The activities of the Establishment have been planned broadly to cover the next five years beyond which the Committee considers it difficult to plan with any degree of accuracy. In the case of the engineering group, the plan covers only the next year. The Establishment at Trombay will consist of three main groups—the Physics, the Chemistry and the Engineering Groups. A unit of the Medical and Health Section will also be located at the Establishment. The scientific staff in the three groups groups of the Establishment at present totals some 200 scientists. It is envisaged that by 1959 the corresponding staff will increase to about 800. Pending construction of the necessary buildings at Trombay, the bulk of the activities of the Establishment are at present located, for facility of work, in the Tata Institute of Fundamental Research, at the Old Yacht Club premises and at Colaba. The said club premises have been taken on lease in entirety for a further two years to meet the requirements of the Institute and the Department.

Atomic Reactors

Since the creation of the Department of Atomic Energy with Dr. H. J. Bhabha, D.Sc., F.R.S., F.N.I., as Secretary, in August 1954, atomic energy development in India has progressed rapidly. In particular, the reactor programme of the immediate future has decided and launched upon.

Swimming Pool Reactor

Construction work of the Swimming Pool Reactor has been completed and was set in operation by the middle of 1956. It is a research reactor inherently safe and relatively cheap. It will use ordinary water as moderator. It will enable India to produce radio-active isotopes for biological, medical and industrial research, in addition to training reactor engineers for later projects. The reactor has been designed and built by the personnel of the Indian Atomic Energy Establishment. Fuel elements are being obtained from U.K. Certain auxiliary facilities have also been planned including a graphite workshop and a workshop for the engineering and metallurgy divisions.

Canada-India Reactor

Plan for the setting up of the second reactor have been completed. It will be a high power high flux reactor of the Canadian NRX type. The reactor has been given by the Government of Canada as a gift to India under the Colombo Plan. All internal costs of erecting the reactor will be borne by the Government of India (amounting to about half of the total cost of some Rs. 7 crores). Work on the foundations of this reactor began at Trombay in February 1956. The reactor is expected to go into operation by 1958. It will be a very powerful research tool and will enable India to undertake advanced engineering research and materials testing connected with more advanced types of power reactors. It will also enable experiments on the conversion of thorium into fissile uranium and will give India a prominent position in the field of atomic energy. A number of Indian scientists and design engineers are proposed to be associated with Canadian experts in order to get trained in the erection, operation and miantenance of the reactor. This reactor will use heavy water as moderator so as to produce intense neutron flux. This requisite heavy water is being purschased from U.S.A.

The Physics Group

The Physics Group carried out intense research work with special reference to the reactor programme in various fields, namely, theoretical physics and applied

mathematics, nuclear physics, reactor control (including construction of simulators for the Swimming Pool Reactor and Canada-India Reactor), electronics, air monitoring and health physics. During 1955, a reactor film badge service and laboratory monitoring service were provide for all persons handling radioactive materials in the Chemistry, Biology and Physics Divisions of the Atomic Energy Establishment and for some outside institutions. The programme for 1956 includes the personnel monitoring service with pocket dosimeters for chambers, and further research work on important nuclear and reactor problems in the several sections.

The Engineering Group

The Metallurgy Division was set up in 1955 and work was done on the production of uranium and thorium metals, powder, alloys, etc. and on designing equipment. The programme for 1956 includes thermal and corrosion studies and studies on uranium, zirconium and canning. During 1955, the Engineering Division conducted studies on the layout of the Swimming Pool Reactor and the reactor cooling system and developed necessary designs. It also fabricated the necessary structural components. It has been engaged on the erection work of the Swimming Pool Reactor. In 1956, the Division will be operating the Swimming Pool Reactor and will also be associated with the design and construction of the Canada-India Reactor.

The Chemistry Group

The major work of the Chemistry Division was on the analysis of mineral samples and trace impurities in materials. More than 1,500 samples were handled during 1955. A new method for the recovery of uranium has been investigated. It reduces a number of steps and gives a purer product. The Division also investigated the extractability of uranium in about 20 different core samples from the Bihar and Rajasthan areas. The complete monazite structure is under study. A 200 KV high electron defraction camera is being designed and built.

Medical, Health and Biological Division

In addition to the film badge service already mentioned, the Division continued the routine blood count service and annual complete physical examination on persons handling radioactive materials. Electron microscope studies and other cytological investigations in relation to radiation have been continued.

Raw Materials Division

During 1955 geological and geophysical survey and prospecting for minerals of use in atomic energy was continued in various parts of India. The Bihar Mica Belt revealed the occurrence of a number of new deposits of columbite, tantalite, beryl and uranium bearing minerals. Two active belts have been recently located in Udaipur area. The Travancore-Cochin monazite survey is now nearing completion and the figures of ilmenite and monazite reserves are being finalised. The Shankara Mica Mine in Nellore District is being examined for radioactive minerals. Reconnaissance survey of the Madras beach has revealed appreciable monazite deposits. A number of aerial flights were made in a helicopter covering the Arvalli area. In order to obtain reliable data, the method of recording air readings is being improved.

Drilling was done in Rajasthan area (14 holes totalling some 3,000 feet) and in Singhbhum area, Bihar (24 holes totalling over 4,200 feet plus 5 old bores reopened totalling 2,000 feet). Exploratory drilling in the Dariba copper mine has disclosed uranium ore deposits capable of easy beneficiation. A programme is being drawn up for carrying out mining work in the prospects proved by drilling to be commercially workable. This development will be carried out departmentally. A mining lease arrangement with the Bihar Government is awaited.

During June, 1955, three geological field parties visited Kulu, Kumaon, Garhwal (Himalayas) and the Nilgiri hills (Malabar) for reconnaissance survey and propaganda to educate and to enlist the cooperation and help of private individuals in prospecting for atomic minerals.

The Raw Materials Division Physics Laboratory completed the emanation electroscope with which to measure radioactivity of springs. During 1955, the staff of Physicists did logging of 71 drill holes aggregating some 11,000 feet. They assayed 3,700 feet of cores (and 282 samples from private parties) for rranium and thorium. The staff did maintenance and repair of 150 radiation meters in use. 70 ilmenite export consignments were sampled and their monazite content checked. A four month training course for junior Raw Materials Division officers was conducted at the Andhra University, Waltair from July 1955. The Division took over on lease the opium factory buildings at Kotah and is using them for stocking atomic energy minerals (including beryl ore) perchased by Government from prospectors and miners.

Information Division

The information service and translation service service under this Division were continued for the benefit of research workers of the Atomic Energy Establishment.

Industrial Operations

Indian Rare Earths Ltd.—Monazite Processing Plant at Alwaye

Indian Rare Earths Ltd., owned jointly by the Government of India and the Government of Travancore-Cochin, continued producing rare earth products and trisodium phosphate as usual, out of monazite sands. The residual thorium uranium cake is sent up for further processing to the Trombay plant, which the company runs as an agent of the Government of India. The Alwaye plant has been in production since 1952 and it has now been decided to increase its processing capacity from 1,500 tons to 3,000 tons of monazite per annum in order to obtain the requisite quantity of uranium for the reactor programme undertaken by the Department.

Thorium/Uranium Plant at Trombay

The Thorium-Uranium Plant was set up by the Department at Trombay to process the residual thorium uranium cake from Alwaye. The plant commenced production from 1st August 1955. The capacity of the plant has since been increased nearly five-fold in order to fulfil commitments in respect of the supply of thorium nitrate, and also to feed the proposed uranium processing plant. The fuel value of the thorium and uranium produced at the Trombay plant will be equivalent to about a thousand million

tons of coal per annum or roughly 30 times the total coal produced in India annually today.

Uranium Processing Plant

It is essential that India should be prepared to supply her own uranium and thorium and produce her own fissile materials, if India is not to be relegated to an inferior position in the field of atomic energy. India is the only country in the whole of Asia and Africa, which is in a position to develop fissible resources without external aid. It has, therefore, been decided to set up immediately a plant using solvent extraction or other process to treat the impure uranium extracted from monazite to the metal stage. The setting up of a larger plant will be considered at a later date.

Pilot Plant at Ghatsila for the extraction of uranium ore

A Pilot Plant for the extraction of uranium ore from the copper tailings of the Indian Copper Corporation is being set up at Ghatsila in co-operation with the Corporation. The plant will initially treat about 200 tons of tailings per day and if the process turned out to be economical, the plant will be enlarged. The plant will be developed in such a way as to enable also beneficiation of the low grade uranium ores from deposits of Bihar and elsewhere.

Titanium Pilot Plant

It is proposed to set up a Pilot Plant for the production of titanium sponge metal from the rutile and ilmenite sands available in India. Negotiations are in progress with Messrs National Lead Company of America who possess the necessary know-how.

Nangal-Heavy Water-Fertiliser Plant

Heavy water is an essential material for a comprehensive atomic energy programme. It is not at present produced in India. It has now been decided that one of the new fertilizer factories to be set up at Nangal in the Punjab should be closely associated with the production of heavy water. Project reports for the joint production of heavy water and fertilizer at Nangal are being prepared by Messrs Vitro Engineering Division and Messrs St. Gobain, Chauny and Cirey, whom the Production Ministry have engaged as consultants for the purpose. A project report on heavy water production at Nangal, Sindri and other places is also being prepared by Messrs Costain-John Brown, who have been engaged as additional consultants for the purpose by this Department.

Corporation for Mineral Sands Separation Industry

After neogtiations with the Travancore-Cochin Government, it has been decided to consolidate and rationalise most of the mineral sands separation undertakings in the State. The idea is that the undertakings under the State Government will be taken over by a new Corporation, whose shares will be held jointly by the Government of India and the Government of Travancore-Cochin. It is expected to complete the arrangements soon. The undertakings will be rationalised with a view to increasing the production of the various minerals contained in the mixed sands of the West Coast and winning all mineral values.

Research Projects financed by the Department

During the year under review, the Tata Institute of Fundamental Research continued to help the Department by offering its equipment and facilities for the research projects of the Atomic Energy Establishment. The Institute also continued the development and production of essential equipment and apparatus such as Geiger Counters. During the year under report, the building programme of the Institute at Colaba in relation to its projected expansion of activities was approved. The question of the annual block grant to the Institute in the same context is under consideration. The support of the Government of India to this Institute has steadily increased. The Government of India today contributes over ninety per cent. of the budget of the Institute. In order to make the Government of India an official partner in the enterprise and give it a bigger share in running the Institute, a Tripartite Agreement was finalised between the Government of India, the Government of Bombay and the Sir. D. J. Tata Trust, whereby the three parties will jointly run this Institute in future with, of course, the Government of India having a major voice and responsibility in running it. The Government of India have now recognised the Institute as the national centre for advanced study in fundamental research in nuclear science and mathematics.

Furthermore, the Department continued to give financial assistance for specific research projects entrusted for being pursued at the various Universities and Research Institutions in the country. The Department is advised in this work by the Board of Research in Nuclear Science (which replaced the old Board of Research on Atomic Energy) and the various Advisory Committees, namely, Chemistry Advisory Committee, Cosmic Ray Research Committee and the Biological & Medical Advisory Committee. It is proposed to set up in the near future Advisory Committees for Metallurgy, Engineering, etc. During the year under review, the Chemistry Advisory Committee was constituted and the Cosmic Ray Research Committee was reconstituted.

Government has recently approved of a five year development programme for the Institute of Nuclear Physics, Calcutta, and have agreed to a yearly block grant-in-aid to the Institute aggregating to about Rs. 57 lakhs over the five year period commencing from 1955-56.

The Physical Research Laboratory receives grant-in-aid from the Department for the maintenance of its electronics and theoretical physics departments.

Fellowships to Indian Research Workers and Foreign Fellowships

In order to provide necessary training facilities to young Indian research workers in the field of nuclear science, 6 senior research scholarships of Rs. 400 p.m. each and 10 junior research scholarships of Rs. 250 p.m. each have been instituted. The fellows are required to work at selected institutions. Ten junior foreign fellowships tenable in India have been instituted for study and research. The fellowships carry a fixed stipend of Rs. 600 p.m. each in Bombay and Rs. 500 p.m. each in other places. They are tenable in the following nuclear science subjects, namely, (a) Experimental nuclear physics—3 ; (b) Theoretical physics—2 ; (c) Nuclear Chemistry—2 ; (d) Metallurgy —2 ; and (e) Radio Biology and/or medicine—1.

Visiting Scientists

During the year under review, Professors C. L. Siegal, M. Eichler, S. Mandelbrojt, E. Bompiani and Paul Turan visited India as Visiting Professors at the Tata Institute of Fundamental Research, Bombay, where the Laboratories of the Atomic Energy Establishment of the Department are located. In addition, Professor Jean Brachet, an eminent scientist from Brussels, at the invitation of the Government, stayed in India for about two months and delivered lectures to the members of the Atomic Energy Establishment. He and other Professors visited several places in India and delivered lectures at the Universities of Madras, Delhi, Aligarh and Baroda.

High Altitude Cosmic Ray Station

As mentioned in the report for the year 1954-55, Messrs Gillanders Arbuthnot & Co., Ltd. carried out the engineering reconnaissance survey for the construction of a ropeway over the Tangmarg-Gulmarg -Khilanmarg-Apharwat area in Kashmir in connection with the setting up of a High Altitude Cosmic Ray Station. The firm submitted a report which is being examined.

Supply of Radioactive Isotopes

According to the procedure laid down, all applications for the supply of radioactive materials from U.K., U.S.A. and Canada are received in the Department of Atomic Energy in the first instance and after the Department has satisfied itself that the applicant institutions have the necessary facilities for the safe storage of the materials and have adopted the necessary protective measures for handling such materials, the applications are fowarded to the authorities concerned. Demand for the import of radioactive isotopes has been steadily on the increase as radioactive isotopes are finding increased use in biology, medicine, agriculture and industry.

International Events

(*i*) *Geneva Conference.*—In the international field, there were developments of far-reaching importance during 1955. The International Conference on the Peaceful Uses of Atomic Energy held in Geneva in August 1955 has been universally acclaimed as the biggest Conference so far organised by the United Nations and the biggest Scientific Conference ever held at any place at any time. Dr. H. J. Bhabha, Secretary of the Department of Atomic Energy, was chosen to be President of the Conference. Two members of the Indian Delegation, namely, Dr. V. R. Khanolkar and Dr. D. N. Wadia, were selected as Chairmen of two of the Sessions, while two others, Shri H. N. Sethna and Dr. J. Shankar, were selected as Vice-Chairman of two other Sessions. The Indian Delegation presented 16 papers to the Conference, of which 12 were chosen by the Advisory Committee of the Conference for oral presentation, a number larger than that selected from any other country except Canada, France, U.K., U.S.S.R. and U.S.A. Apart from the contributions made by Dr. Bhabha, Leader of the Indian Delegation and the President of the Conference, to which wide-spread reference has been made both in the foreign press and also in the statements made by the representatives of various nations to the Main Political Committee of the United Nations in October 1955, the Indian Deleagtion was recognised to have made substantial contribution. The mention by Dr. Bhabha in his opening address of the possibility of obtaining 'power for peaceful purposes from the fusion reaction hitherto only used in the hydrogen bombs, elicited the most widespread comment in the press of the world and eventually resulted in U.K., U.S.S.R. and U.S.A. admitting that they had been working secretly on this problem.

On the scientific and technical side, the Conference led to four broad conclusions. First, it established that there is enough uranium and thorium widely distributed in the world to sustain an expanding power programme in the entire world at the maximum rate possible for many centuries. Secondly, breeding was shown as possible in thermal reactors using thorium, and the thorium-uranium-233 fuel cycle was shown to be superior to the uranium 238-Plutonium cycle, a conclusion of great significance for India which has a vast supply of thorium in monazite sands. Thirdly, it was established that in fast reactors, breeding is possible with uranium as well as thorium. It will be possible in future to extract as much energy from a ton of uranium or thorium as from between $2\frac{1}{2}$ and 3 million tons of coal. Fourthly, it was established that electricity from large atomic power stations of 100,000 killowatts or more would be competitive with electricity from conventional thermal stations in regions where coal costs are high and hydroelectric potentialities small. There are many regions in the world, especially in the underdeveloped areas, where electricity would be acceptable at the cost of even 30 mills per unit (which is the estimated cost of an atomic power plant of two to five thousand killowatts).

(*ii*) *International Atomic Energy Agency.*—Such an Agency is being planned at present in order to foster co-operation and exchange of knowledge equipment and materials in the development of nuclear energy for peaceful purposes. A draft statute of the Agency is being considered at a Working Level Meeting of certain sponsoring countries, which met in U.S.A. in the last week of February 1956. India has also been invited to the meeting. The draft statute is to be considered by a General Conference of Nations hereafter.

(*iii*) *Scientific Committee on Radiation.*—The question of the effects of ionising radiation and radioactivity in relation to man and his environments has been under discussion at the United Nations and a Scientific Committee has been set up, of which India is a Member, to compile and assemble in an integrated manner the various data and reports received from Nations relating to this subject.

Collaboration with other countries

India is in close collaboration with numerous other countries in the field of atomic research and development and has formal agreements with some of them. Among other agreements may be mentioned an umbrella agreement concluded with U.K. in 1955, providing generally for co-operation and mutual help and enabling specific projects for co-operation to be undertaken when mutually approved. In this way, supply of fuel elements for the Swimming Pool Reactor has been arranged. Supply of heavy water for the high flux reactor has also been arranged through another agreement with U.S.A. The Canadian Reactor has been accepted under the Colombo Plan. A Techni-

(*Continued on page* 9)

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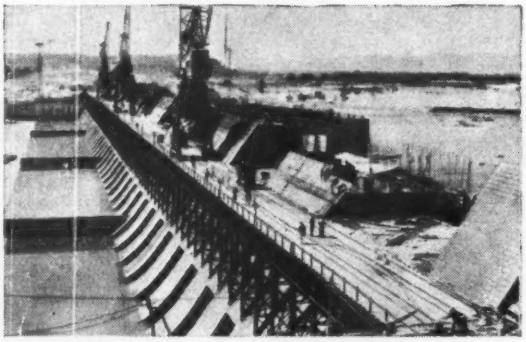
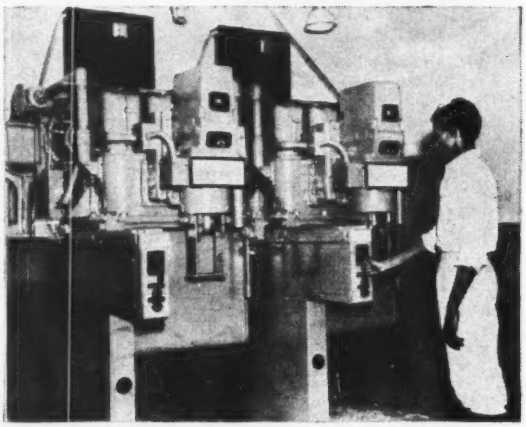
Many steam turbo-alternator sets have also been supplied for a wide variety of installations, including power stations, chemical works, textile mills, railways and collieries.

Several million KVA of transformers have been supplied for operation in India and all the recent substations of the Calcutta Electric Supply Corporation are equipped with 'English Electric' Units.

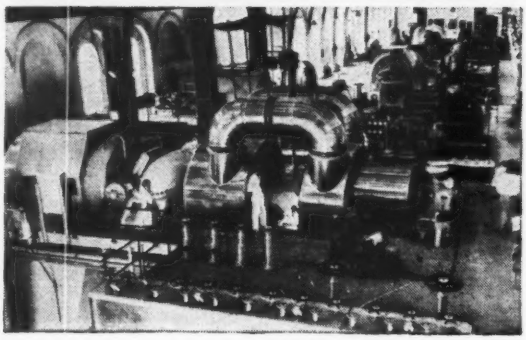
Eleven substations of the Bhakra-Nangal Grid are being completely equipped with 'English Electric' Transformers and associated switchgear.



HIRAKUD DAM PROJECT, ORISSA: For this Project the English Electric Company is supplying two generating units, each unit consisting of a 52,000 H.P. Vertical Shaft Feathering Propeller Turbine coupled to a 37,500 kW semi-umbrella type generator.



OIL REFINERY, TROMBAY, BOMBAY: All the transformers totalling over 20,000 KVA capacity together with the associated high and low tension switchgear were supplied by the English Electric Company to the Standard-Vacuum Refinery at Trombay. The illustration shows two of the 5-panels 22 kV 500 MVA Switchgear installed at the Refinery.



RIVERSIDE POWER HOUSE, KANPUR: 'English Electric' Steam Turbo-Alternator Sets are installed at this Power House. The associated Transformers and Switchgear are also supplied by 'English Electric'.

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EEX 22 NEW DELHI BOMBAY MADRAS CALCUTTA LUCKNOW

Concrete Semi-Spiral Casing at Sarda Power House

By

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Executive Engineer, Irrigation Department, Uttar Pradesh

AUTHOR

Sarda Power House which started generation of power early in 1956 presented many intricate design problems. The article gives in brief the analysis of the concrete scroll case.

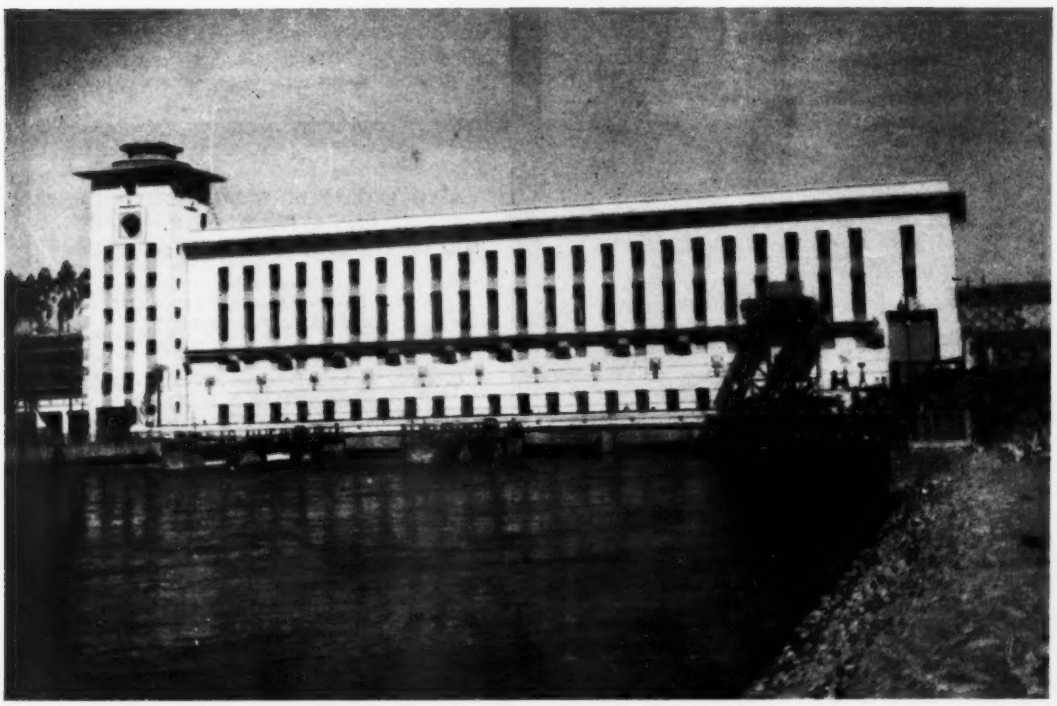
The concrete semi spiral scroll case setting was favoured at Sarda Power House because it was considered the most appropriate type for its static head of about 69 ft. and because the stipulations of Messrs. English Electric Company, the suppliers of the plant, were also in its favour. Figure I gives the outline plan of the Power House.

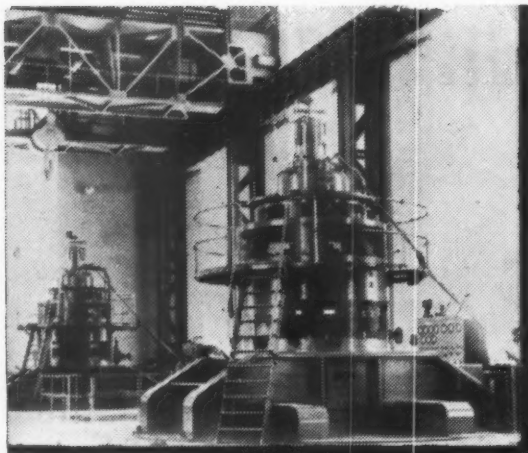
The design of concrete scroll case was based on the water passage dimension fixed by the plant suppliers. The portion at the beginning, where its walls are spanned by a deep upstream main beam, was considered as a framed structure, but will not be discussed here. The rest of concrete casing was designed as a pipe whose cross sectional area varies along the scroll and which is discontinuous on the inner side though it is connected there through the speed ring.

The bottom of the casing forms part of the power house sub-structure and required little analysis; but the walls and the roof will deform under internal water pressure or loads from above and therefore they needed detailed study. The spiral casing was therefore divided into the roof, the walls and the bottom for its design.

The reinforcing steel has been provided for all the

View of the Sarda Power House





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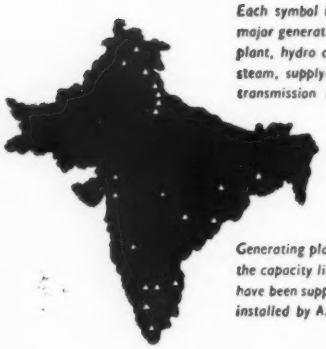
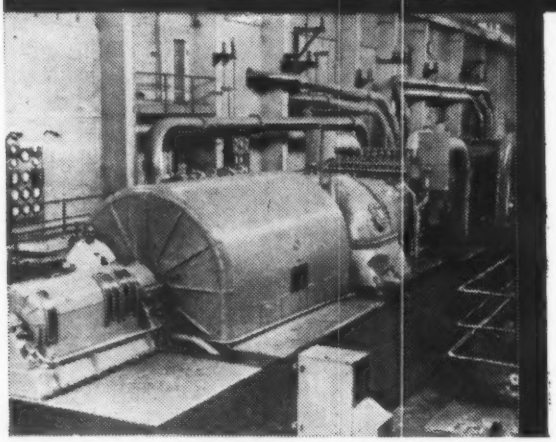
• Visakhapatnam	6,750 KW
• Tatanagar	55,000 KW
• Kashmir	6,000 KW
• Jogindarnagar	48,000 KW
• Greater Calcutta	1,61,000 KW
• Madras (Basin Bridge) • Pykara, Mettur, • Papanasam and Moyar	2,15,450 KW
• Mysore (Jog)	48,000 KW
• Travancore	22,500 KW
• U. P. (Harduagang) • Bahadrabad, Bhola, • Sumera & Muhammadpur	40,600 KW
• Bhakra dam	500,000 KVA

Plant under manufacture



Each symbol indicates major generating plant, hydro and steam, supplying grid transmission lines.

Generating plants of the capacity listed have been supplied and installed by A.E.I.



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forces envisaged and inclined reinforcement introduced. at all corners to take care of any cracking tendency The details of reinforcement so provided are shown in *Fig. 2.*

Spiral Roof

Spiral roof is a reinforced concrete slab which is curved in plan and spans between the spiral wall and the speed ring upto section 14. It is 6.83′ thick (though only 4.33′ thickness was considered for structural strength as 2.5′ thick concrete at top will be laid at a later date). It is haunched towards speed ring where it forms 16.08′ thick generator plinth.

The slab was assumed as consisting of numerous radial strips intercepted by vertical planes through the centre of turbine pit for computations and it was designed for the following loads :

(*a*) Dead load of the concrete forming roof slab and generator support plinth. The dead weight of concrete was taken as 150 lbs./ft. ^{3} ;

(*b*) 1,000 lbs./ft. ^{2} of incidental loads to account for live loads tributary from turbine and generator floors above;

(*c*) Internal water pressure due to 62.9′ head of water acting on the underside of the roof, plus 12′ of water hammer as specified by the manufacturers of the plant; and

(*d*) Forces transmitted from spiral walls acted upon by internal water pressure when the spiral is full.

The joint between the roof slab and outer wall was considered completely fixed, but the degree of fixity on the inner support with the speed ring and generator barrel was not relied upon, in spite of special measures taken to obtain a rigid joint as the speed ring and generator support are made of steel while spiral roof, of reinforced concrete. Calculations were therefore made for both conditions of fixity (*a*) when inner end is also fixed; and (*b*) when inner end is free.

The following conditions of loadings were considered : (*a*) Scroll case is full, i.e., when the internal water pressure due to head pressure plus water hammer less tributary dead load on top are acting and causing the roof to deflect upwards; and (*b*) scroll case is empty, i.e., when full external loads due to dead and live loads tributary from the floors above are acting and causing the roof to deflect downwards.

The strips at sections 2-4-6-8-10—2 and 14 were analysed in detail. These strips were assumed trapezoidal in plan with 1′ width at their outer end where they join the spiral wall. The moments and reactions were calculated for free supports in the first instance and were afterwards modified to account for the continuity over the supports.

For obtaining fixed end moments, the elaborate procedure of analysis by the theory of elasticity was not followed but instead, the strips were analysed by simpler method of column analogy. For this the analogy between the stress formula $fdA = P$ for the strut and flexural rotational formula $mi \frac{ds}{EI} = -\phi$ for the beam is made use of and the moments 'mi' necessary to preserve the continuity over the ends are found as fibre stress 'f' for a short strut having load ϕ, and having the same dimension of the cross-section as the beam except that it has widths equal to $\frac{I}{EI}$ values of the beam.

The maximum sagging and hogging bending moments at the supports, at the beginning of the hauch and in the middle of the slab were obtained and the main reinforement in the strips was then calculated for the severest conditions of bending moments at various points combined with the direct pull from the spiral walls in case when the spiral was full. The outer spiral walls are comparatively rigid except at sections 12 to 14. The transference of moment from spiral wall was therefore ignored except for section 12 and 14. However reinforcement in sections 12 and 14 also was provided without accounting for any such transference, as this condition determined heavier reinforcement.

As the cross-section of the casing varies uniformly thus obtaining nearly a constant velocity distribution around the scroll and thereby ensuring uniform pressure, the distribution of stresses as a result of the diminishing cross sections was disregarded. Only distribution reinforcement 0.4% of concrete area was provided and tied to the main upstream beam. This was considered sufficient to take care of any transverse bending moments.

The generator plinth was reinforced heavily by circular hoops, verticals and radials throughout its depth to account for a twisting moment of 230 tons at 21′ diameter specified by manufacturers of the plant. The hoops in the generator plinth in the lower portion equivalent to structural depth of the roof slab were made somewhat heavier for proper transmission of stresses from thin slab to the generator plinth.

The roof slab beyond section 14 could not be treated as radial strip except the portion between section 14 and corner with the upstream beam. The same was therefore treated spanning between the speed ring and main upstream beam and reinforcement was proposed accordingly.

Spiral Walls

For analyis, the spiral walls were divided into following categories, (*a*) spiral wall on downstream side running parallel to the power house axis; (*b*) and spiral walls perpendicular to the power house axis acting as divide walls between the units; and (*c*) spiral walls forming abutments to the power house building.

(*a*) *Downstream wall of the spiral casing*

Inner face of the wall follows the profile of the spiral and therefore the section of the wall increases on both sides from minimum at the centre line of the unit to maximum on the massive corners forming junctions with the divide walls and the abutments. The wall spans betweeen the spiral bottom and the spiral roof with which it is rigidly connected. It also spans in the other direction between the piers and divide walls of the diffuser chambers located downstream and cast monolithic with the spiral walls. Two way reinforcement was therefore provided in the wall and was designed for following conditions of loading :

(*i*) Spiral is full and there is no tail water downstream—This will require reinforcement on the outside face in the middle portion of the span and reinforcement on the inside face at the supports.

(*ii*) Spiral is empty and there is maximum tail water level downstream—This will determine reinforcement on the inner face in the middle of the span and reinforcement on the outside face at the supports.

The pull from spiral wall was also considered for condition (*i*). This pull is maximum when the inner end of spiral roof is assumed free. The provision of the reinforcement for condition (*i*) was therefore based on the same value of pull. The vertical load transferred by the superstructure which has a stabilising effect against the pull was neglected.

As the wall is punctured by two discharge regulators in its middle the reinforcement as provided does not remain continuous where these regulators are located. Adequate reinforcement was hence provided around the discharge regulators and main reinforcement was tied to it. The main reinforcement was also checked for cantilever action of wall for the two conditions of loading and was found safe.

(*d*) *Spiral walls acting as Divide Walls*

These walls were designed as spanning between spiral roof and base. The following conditions were considered :

(*i*) Spiral case is full on both sides; and
(*ii*) Spiral case, on only one side, is full.

The wall was analysed in detail only at the sections 2 and 3 where it was weakest but the reinforcement was provided in the entire wall on its basis.

The bending moments and pull in the spiral wall at its top and bottom were obtained for various cases of loading and fixity of roof at the speed ring. The method of moment distribution for evaluating the moments was used. The fixed end moments for moment distribution were obtained by column analogy method as explained earlier.

The reinforcement was thereafter obtained for the severest cases for combined pull and bending. The effect of pore pressures in the wall was also considered to account for the worst possible condition.

As the thickness of the divide walls at minimum section was only 4.6′, the reinforcement was provided slightly more and vertical bars were also introduced in its mass.

Distribution bars were provided on both faces of the spiral wall. The spacing was kept closer in the middle and was increased near supports. The distribution reinforcement in the middle was kept heavy in order to resist any tendency of spiral walls deflecting like the walls of a thin cylinder, although such behaviour is remote due to the walls being rigidly connected to the extensive spiral roof and the rigid base which are further joined in the middle through speed ring. Further, three casing are located side by side and restrict any such deflection. However, the above precaution was taken in view of the importance of the structure.

(*c*) *Abutments*

These are quite rigid and need almost no description. These were tested for pull from the roof and the bending moment when acted upon by internal water pressure. The effect of distribution of moments from the roof was also provided for.

Spiral Bottom

This was designed as part of the rigid sub-structure. Radial bars with circular distribution reinforcement were, however, provided arbitrarily.

(*Continued from page* 25)

Silt in relation to Storage Reservoirs

tours and compute and compare capacity for a given elevation.

In case of large reservoirs such methods cannot be applied as it would involve time and expense. In such cases volumes are found out by soundiug by means of supersonic sounding equipment, along the silt ranges established unsually at the time when the project is built. This type of capacity surveys are carried out once in 4 to 5 years. This equipment, Echo Sounder as usually called, determines water depths by utilising supersonic sound pressure waves and precision timing. It gives a permanent and continuous record on a caliberated chart of depths of water through which the sound waves are sent. The echo sounding equipment is operated from a boat suitable for carrying the equipment and operating personnel.

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Control of High Voltage Motors by Contactors

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Now-a-days more and more high voltage motors are being used for the drive of large capacity machines. The word "high voltage" as used here is rather improper; since it denotes motors working at 1000 volts or more. The voltages commonly used range from 2,000 to 6000 volts (The usual values are 2,300 & 4,600 volts in the U.S.A. and 3,200 and 5,000 volts in France). In addition to the decrease in size and weight of motors, the other advantages of using high voltage motors are: elimination of transformation stage, decrease in first cost, particularly for cables and improvement in efficiency and power factor.

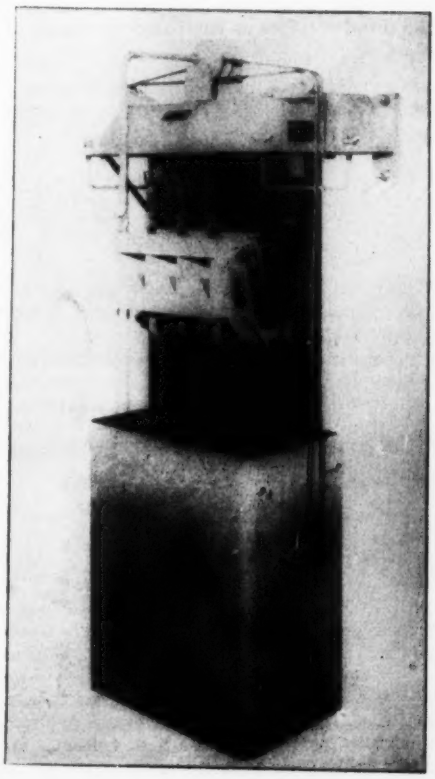
The control of motors chiefly consists in starting and stopping and sometimes variations of speed. Different types of control equipment were used with more or less success. In the early stages, circuit breakers designed for 11 K.V. and even 17.5 K.V. were used. The essential difference between a circuit breaker and a contactor is that a circuit breaker is meant to interrupt high short circuit currents only a few times, whereas a contactor interrupts its rated current and moderate overloads a great many times (may be a few million times). As such, the circuit breakers that were tried, proved unsatisfactory for frequent starting. Therefore, special contactors suitable for the operation of high voltage motors were manufactured. The use of high voltage contactors made it possible to get all the advantages of magnetic contactor control eg. flexibility, safety, automaticity, and ease, etc.

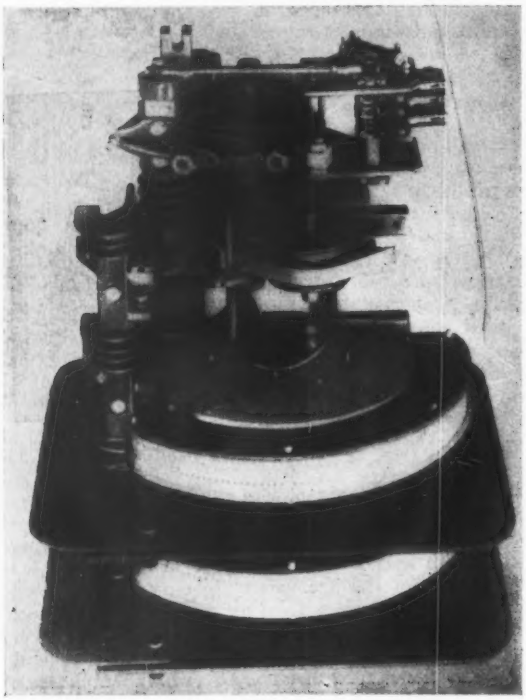
Before considering the contactor proper, it is worthwhile to mention that damage to motors in most cases is caused by dangerous transient overvoltages. This important problem was the subject of a symposium organised by La Societe' Francaise des Electriciens in 1953. (the proceedings are published in the Bulletin de la S.F.E.—August and November 1953 issues). One of the points brought out and which concerns the control equipment is the great importance of the overvoltages produced at the time of circuit interruption. It was shown that certain equipments, particularly those with forced blow out are susceptible of giving rise to dangerous overvoltages, but that is not the case with the oil-immersed or magnetic-blow out types, which interrupt the current at its passage through zero.

Fig. 1. gives' a photographic view of 100 amp-2,500V (350 h.p.) contactor of the oil immersed type. The contactor resembles a conventional low-voltage contactor. Oil serves to insulate current carrying parts from each other and from ground and also for quenching the arc. No blow outs are provided since the arc is extinguished by the high pressure and turbulence of gases and vapours prouced by the arc. Insulating barriers are provided between poles and minimize the hazard of an arc-over between phases.

The good insulating and arc extincting property of oil and the protection that it provides against corrosion

Triple pole oil immersed a.c. contactor, 100 amps., 2500 volts.





Triple pole magnetic blowout air break contactor with the left hand arc chute removed to show details, 700 h.p., 6,000 V.—(Telemecanique Make, type K)

of metal parts are an advantage for oil immersed contactors, but they are far outweighed by the following disadvantages as compared to the air break equipment.

(*i*) Fire hazard due to presence of a mass of oil—particular care should be taken to avoid oil leakage.

(*ii*) Contacts burn away more rapidly under oil than in air and as such oil immersed contactors are not suited for motor controllers that operate frequently.

(*iii*) Complications associated with drawing out of oil for inspection or maintenance of contacts.

(*iv*) Dependence on an external medium for are extinction. (This holds good for oil, compressed air, or auxiliary source e.g. storage battery etc.)

(*v*) Sludge formation in oil that needs periodic cleaning.

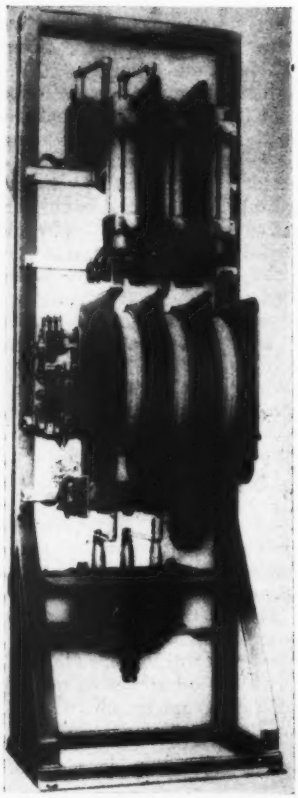
Fig. 2 shows a triple pole magnetic blow-out air break contactor (Telemecanique make—type K) with the left hand arc chute removed to show the details of the contacts assembly and blow out coil. It is rated 700 h.p. at 6000 V and very closely resembles the conventional low voltage contactor makig use of a single shaft. The poles are separated by insulator plates. The three movable contacts are mounted directly on a rod rigidly connected to the armature of the electromagnet. *Fig.* 3 shows frame mounted equipment for direct on-to-line starting of a high voltage squirrel cage motor using such contactors.

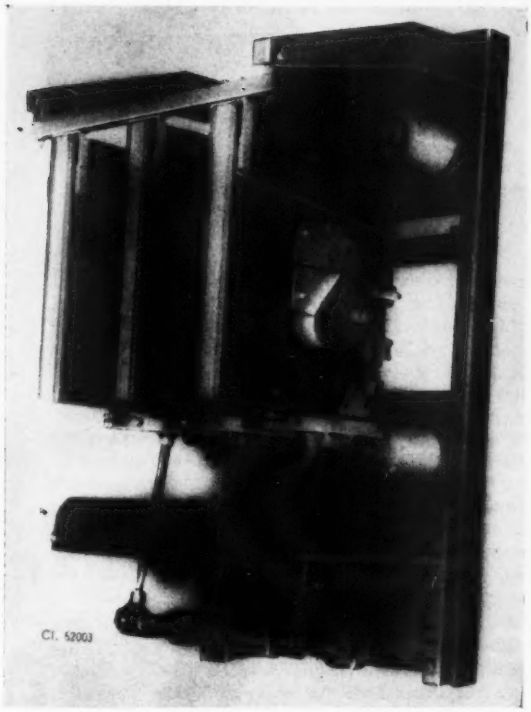
Fig. 4, shows a three pole contactor for higher rating i.e. 2,500 h.p. at 6000 V (Telemecanique make—type H). It differs from the K type in that the single shaft is replaced by a chassis and the 3 movable contacts are operated individually by connecting rods. *Fig.* 5 shows completely enclosed equipment for the starting of a high voltage slip ring motor with resistance in the rotor circuit.

Amongst the numerous applications of high voltage contactors mention should be made of their use in chemical and petrol industry, rubber and sugar industry mines, metallurgical industry, electric power stations, to name only a few. They are also coming into use for medium capacity machines such as pumps, ventilators, compressors, grinders, winches, etc. Regarding the mechanical strength, it may be worthwhile to quoted the figures given by La Telemecanique Electrique—Tests have shown that after 3 million trouble free operations no trace of appreciable wear and tear was noticable, and the figure of 10 million operations now certainly seems well within the possibility.

A recent improvement made by La Telemecanique Electrique on the H type high voltage contactor is the addition of a device for the compensation of electrodynamic forces. *Fig.* 6 shows the details of contact of such a contactor (Telemecanique Make—type J) with the arc extinction chamber removed. The figure on the left shows the contacts in open position, while on the right hand figure, the contacts are closed.

Frame mounted contactor equipment (Telemecanique Make, type K) for direct on to line starting of squirrel cage motor.





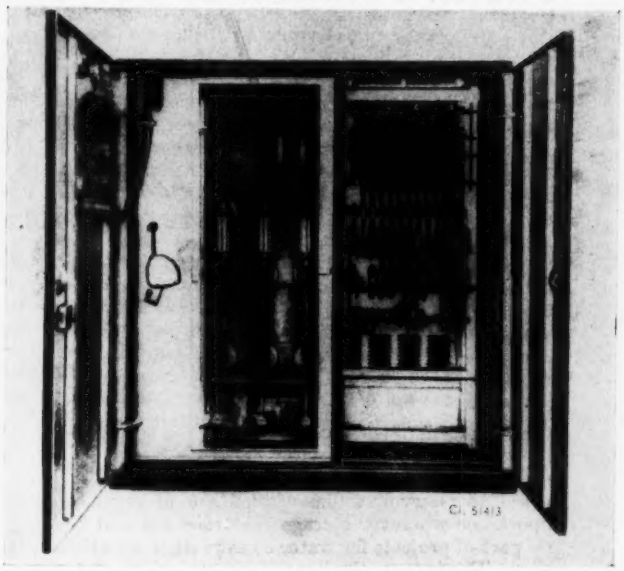
Triple pole magnetic blowout contactor, 2,500 h.p., 6,000 V.—(Telemecanique Make, type H).

Now coming to the problem of protection a little; the very principle of a magnetic contactor provides no-volt protection and thermal relays are generally used to provide protection against overloads. The only difficulty arises with protection against short-circuit. When motors are supplied by high capacity networks, it may not be posible for the contactor to deal with heavy short circuit currents and in such cases high rupturing capacity fuses having suitable characteristics are employed as shown in figs. 3 and 5. There the contactor breaks over-load currents upto a certain limit (greater than the current taken by the motor with rotor stalled) and the fuse operates for higher currents. But it should be remembered that for a suitable coordination, it is necessary to know the exact characteristics of the fuse and relay. The fuse, if quick operating, will have the remarkable property of limiting the amplitude of fault currents. The contactors with the complementary relays and fuses can be used in a variety of equipments to suit given conditions. Actually a complete equipment will depend on :

(*i*) the type and characteristics of motor to be controlled.
(*ii*) Supply voltage and frequency.
(*iii*) method of starting.
(*iv*) the conditions of exploitation and installation.
(*v*) service to be ensured.

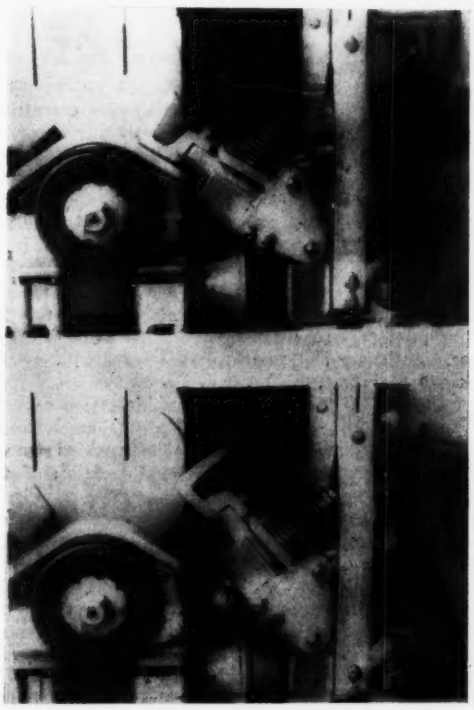
Acknowledgements

I wish to express my gratefulness to La Telemecanique Electrique, France and in particular to their Mr. M. Goust for having so willingly supplied information and photographs for inclusion in this article.



Completely enclosed contactor equipment for starting of slip-ring motor.

Details of contact with the device for compensation of electro-dynamic forces (arc extinction chamber removed); left-contacts open, right-contacts closed. (Telemecanique Make, type J, 5,000 V)



Silt in relation to Storage Reservoirs

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The problem of silting of reservoirs has been engaging the attention of many in view of the fast development of multipurpose projects. Investigations with respect to reservoir sedimentation are of significant importance wherever storage reservoirs are and integral part of projects for water conservation an utilisasation. This is true whether the reservoirs be for Irrigation, for hydro power development, for flood control, for domestic water supply etc. or for any other uses.

The following are some of the important factors which influence the reservoir sedimentation.

(*a*) Magnitude of watershed and its characteristics such as geology, types of cover, climatic conditions etc.
(*b*) The method of reservoir operation used, and
(*c*) The effect of the upstream reservoirs, if any.

Factors to be considered in estimating the life of a reservoir

In estimating the life of a reservoir the correctness of the estimate mainly depends on how accurately the density of the deposited sediment is predicted. This prediction, however, depends on many factors, such as size of particles, rate of compaction and the manner in which the reservoir is operated.

The life of a reservoir is dependent on the ratio of the reservoir capacity in acre feet to the watered area in sq. miles. Where this ratio is small, the life will be relatively small and where this ration is large, other conditions being same, the life will be correspondingly long.

While designing the reservoirs provisions is made for dead storage and the live storage. The dead storage is meant to provide space for the deposition of the sediment during the life of the project. There may be evacuation of sediment through the reservoirs, depending upon the capacity watershed ratio, shape of the basin, type of outlets and operation schedule; however this is generally neglected while allocating the space for dead storage. While allocating the dead storage in most cases "the trap efficiency should be considered at least 95% and only on rare special occasions should it fall below 90%"*. The evacuation of sediment through the reservoir may be considered in case of reservoirs which are designed to pass the greater portion of the annual flood with little or no storage, or in flood control reservoirs where the flood is temporarily held and rapidly evacuated.

In case of series of reservoirs, however, the deposition in the succeedin down streamg reservoirs is influenced by the deposition that occurs in the upstream reservoirs.

Usually single purpose reservoirs are operated at constant levels while the multipurpose projects are operated at various levels as dictated by the needs of various purposes. This variation in water level in a multipurpose reservoir is significant in the deposition of silt in the reservoir and also its movement in the reservoir.

Location of Silt deposit

The location, whether the sediment deposits in the dead storage space or in the live storage, is also very important and this is controlled by various factors such as (*a*) vegetation at the head of the reservoir (*b*) amount of sediment load and size distribution (*c*) shape of reservoir and valley slope, and (*d*) the location and design of the reservoir outlet. At the beginning of the impounding process, the coarser portion of the silt load will be deposited near the head of the reservoir. As deposition continues, the resulting delta front moves progressively down into the lake depending upon the operation of the reservoir and the nature of the sediment load.

Economic significance of silting

Sedimentation decreases the storage capaoity preventing the reservoir from supplying the services for which it was designed thus disturbing the economic life of the region or community which it serves.

By the same rate of sedimentation, reservoirs of comparable size having different service fuaction are not necessarily damaged to the same degree. So as to obtain a high rate of primary power production with most Hydroelectric installations, regulating storage is required. In such cases, loss in reservoir capacity reduces the constant flow that can be maintained through the power turbines. The direct loss from silting can be measured by the kilo, watt hours of electrical energy that could have been produced by utilising the storage capacity available had it not been silted up. The greater the fluctuation in power output from hydroelectric plants, the more standby sources of power such as steam plants, must be operat-

ed. By these added cost of operating stand-by plants, the silting damage can be measured.

Similarly sedimentation damage to irrigation reservoirs can be measured primarily interms of water wasted over spillway which could have been retained and used. With cumulative storage loss from sedimentation, however, the recurrence of occasions of water defficiency progressively increases. Hence crop loss will become more frequent.

In flood control reservoirs, a calculable damage results if its detention capacity is reduced by sedimentation If it is designed to control a 100 year flood after silting, it may control only 75 year flood. Flood control is often provided, however, by gate control detention storage above the pool level maintained for power, irrigation, water supply etc. In such reservoirs flood control may not be seriously affected until the storage capacity at these levels are greatly influenced by silting. Some reservoirs which are mainly constructed for flood control provided with large outlets at the base of the dam pass the flood water at normal stream discharge velocities, hence much of the sediment load may pass through and out of the basin.

Sediment deposits in the upper end of reservoirs generally, become covered by water-consuming vegetation, and result in heavy evapo-transpiration loss. This will represent critical loss of available water especially in the more arid states.

Remedial measures for the control of Silt

The sediment problem arises from man's disturbance of the prehistoric geological pattern. Cutting and burning of bushlands and forests, overgrazing of grasslands and cultivation of croplands have greatly reduced the primeval vegetal protection. The erosion of the soil mantle by the impact of rain drops, wind, and surface run-off has been much more than soil formation. Thus, there is an upset of balance in Nature.

As the silt originates from the watershed the obvious point is to prevent silt from being carried into the reservoir. In regions of moderate rainfall, sheet erosion is the dominant source of total sediment load while in arid and semi-arid regions gullying and stream channel erosion furnish the greater part of the silt load.

We have two basic approaches for controlling the sediment :—

(1) Handling of sediment where it creates a problem (at or near the site of damage).
(2) Controlling of soil erosion from the drainage area.

Soil Conservation measures

The most effective measure, however, is to protect the land by good vegetal cover the success of which depends both on the climate and the land management in the watershed. This will prevent sheet erosion, decrease direct suface run-off and increase infiltration of precipitation. Further it prevents the formation of gullies which contributes large quantities of sediment. The need for food and fibre products, etc., however, make it impossible to maintain all the land surface in forest or grassland though climatic conditions may permit. Therefore, it calls for various soil conservation practices to minimise soil erosion losses consequent on cultivation, grazing etc.

Experimental results in the U.S.A. conclude that sheet erosion on agricultural land can be reduced by 60%, if the farmers adopt the recommended rotations, use contour farming, strip cropping and terracing and other practices depending on capabilities of land, without reducing the level of net income from the land.

Engineering measures

In the arid regions where gully and channel erosion is predominant, the problem will have to be tackled at or near the site of damage and as such engineering measures are necessary. Regarding engineering measures channel erosion control, storage of sediment at all available sites in the watershed have greater importance in controlling silt. The silt can be controlled by revetments, check dams, debris basin, and stream bank stabilisation, etc. These measure, however, should be effectively supplemented by adequate grazing control and watershed management to maintain the sparse vegetal cover of the region.

For large watersheds checking the silt by vegetal cover will be a lon drawn prbgramme an d can only be obtained by public expense. As this method will be a long drawn one, we have to think of immediate methods where more direct control can be exercised. To control the inflow of sediment to impounding reservoirs, the following measures may be adopted (1) Settling basins (2) vegetative screens (3) off channel reservoirs—where topographic conditions permit and where use of entire stream flow is not required (4) partial control by suitable outlets and operation.

The deposits may also be removed by excavation dredging, draining and flushing either by mechanical or hydraulic methods.

Regarding the partial control by suitable outlets and reservoir operation, we may consider the following: Sediment in reservoirs usually moves as a density current or diffused colloidal suspension. Density current is the under flow, where the sediment-laden water, because of its greater density, flows down the bottom of the reservoir. The evacuation of the fine sized particles may be done, if a reservoir is fitted with outlets at various elevations so as to draw large quantities of water. Whether it is practicable to discharge these density currents from a reservoir as a means of decreasing the rate of reservoir silting is still a complex question. The dense flows of fine sediment discharged from the reservoir may damage the downstream irrigation and domestic water installation.

Measurement of Sediment in Reservoirs

In view of the risks involved by the silting of the reservoirs, systematic capacity surveys of various reservoirs are inevitable. Reservoir sedimentation surveys determine the amount of material deposited in a reservoir and show where and how the deposition occurs. The practical objective is to assess more accurately the length of period before which the purpose of the reservoir is interfered with.

In case of small reservoirs sufficient soundings are taken below the water level either by a sounding pole or by lead line so as to permit the drawing of con-

(*Continued on page* 20)

Implementation of Plant and Machinery Committee's Recommendations

In reply to a question in the Lok Sabha, Shri Jaisukhlal Hathi, Union Deputy Minister for Irrigation and Power, laid the following statement on the Table of the House on the implementation of the main recommendations of the Plant and Machinery Committee.

Item	(I) Recommendations of the Construction, Plant and Machinery Committee	Action taken by Government
1. (*i*) Plant Planning	Mechanised construction required that planning with the same care normally bestowed on detailed plans and estimates of a project. Jobs which can be executed by manual labour should not be machanised unless there was a saving of 20% in the cost or period, during which a job could be completed by manual labour.	The State Governments have been advised accordingly.
(*ii*) Multi-shift working.	Mnlti-shift working should be a standard feature and suitable allowance or extra pay should be given to the project staff for shouldering the additional responsibility of multi-shift working and cost control.	—do— This is already in force in the Centrally-financed multi-purpose projects (DVC, Hirakud and Bhakra-Nangal)
(*iii*) Equipment utilisation .	The project should plan for the utilisation of at least 75% life of equipment. There should be no encouragement for mechanisation of isolated jobs of small size.	The State Governments have been advised accordingly.
(*iv*) Provision for ancillary services.	Proper facilities for ancillary services e.g. floodlight, railroad, labour amenities, transport for supervisory personnel, communications etc. should be incorporated in the plan.	—do—
(*v*) Planning of Budget.	To suit the production targets, yearly budgets required for purchase, operation, and maintenance of equipment should be worked out and the flow of the requisite funds should be ensured.	—do— This is already being done in the case of the Centrally-financed multi-purpose projects (D.V.C. Hirakud, Bhakra-Nangal).
2. (*i*) Standardisation of equipment.	For efficient and economic utilisation of equipment a few well tried-out items of construction equipment should be standardised. The supliers of such standardised equipment must have satisfactory spare parts store, proper after-sale service and should also be able to offer technical assistance. The standardisation of power units is equally important. Non-standard equipment should not be used.	In pursuance of the decision of the Coordination Board of Ministers on the matter a Standing Committee has been appointed consisting of the representatives of the concerned Central Ministries and Chief Engineers of major projects. This Committee has been directed to ensure that (a) No advance monopolistic or inflationary tendencies flow from "Standardisation"; (b) Equipment manufactured in India should get over-riding priority as soon as it is available in the country. (c) The number of standardised makes of equipment should normally be from 2 to 5; and (d) manufacturer whose equipment is standardised carry adequate stocks of spare parts. The Standing Committee's recommendations have been accepted in principle by the Government of India and have been referred to the Members of the Coordination Board of Ministers for ratification.
3. Life and depreciation of machinery.	(i) Method of working plant-hour cost has been indicated. (ii) Standards for calculating depreciation and working out flat rates for major repairs etc. have been suggested.	The State Governments have been advised in the matter.
4. (*i*) Provision for spare parts.	Standards have been laid down for total annual requirements of spare parts and other stores.	The State Governments have been advised accordingly.
(*ii*) Procurement of spare parts.	Projects should be allowed to order spare parts requirements either against D.G.S.&D. rate contracts or under normal procedure of tenders. Attention of the Store Purchase Committee should be to the necessity of obtaining spare parts and other materials expeditiously by the projects by delegating adequate powers to the Project Officers.	The D.G.S.&D. and Store Purchase Committee were informed accordingly. The Standing Committee on Standardisation referred to in item 2 above was directed to ensure that the manufacturers whose equipments are standardised carry adequate stock spares and enter into price agreements with D.G.S.&D. Following the acceptance of the recommendations of the Standing Committee for standardisation, D.G.S.&D. have been requested to conclude necessary rate contracts with the manufacturers whose makes are proposed to be standardised.

			A Standing Departmental Committee consisting of a representative of C.W.P.C. and of D.G.S.&D. has been appointed to review periodically the position of indents with a view to removing bottle-necks in the supply of spares and machinery against indents.
	(*iii*) Setting up a Central Organisation under CWPC for Coordination Work.	A Central Organisation under the CWPC should be set up to coordinate the demand for, and the release of equipment. This Organisation should include a wing for scaling of spare parts to help the projects detail their forward demands for stocking and for planned overauls. Every project should have a scaling engineer to work out details of future spare parts requirements.	A Plant & Machinery Directorate is already functioning in the CWPC to correlate the supply of and the demand for the surplus machinery. This Directorate is compiling information relating to equipment declared surplus in projects nearing completion and their transfer to other projects. All the State Govts. have been requested to furnish the necessary information as and when necessary. As soon as a qualified Scaling Engineer is appointed, the scaling wing of this Organisation also would begin to function. A "drill" to ensure the optimum utilisation by projects of serviceable surplus machinery is being finalised.
5.	Proper upkeep of machinery records.	Log books and history books should be maintained properly on all project for all machines. Log books should give to operation data of machine & the history books should record the conditions of machines, their data, capital charges and a summary of utilisation.	The formula for determining the price of old equipment should be the book value less depreciation. In the event of difference of opinion as to the depareciated value of machinery the matter should be settled by joint inspection of two parties and, if necessary, by arbitration. The State Govts. and the project authorities of DVC, Hirakud & Bhakra Nangal have been advised accordingly.
6.	(*i*) Opening of Training Centres.	To get the optimum benefit out of the machinery used it is necessary to employ well trained operational and maintenance staff; training centres should be opened to make up the present shortage.	Two training centres, one at Kotah and another at Nagarjuna Sagar Project have been opened. The question of opening of more centres at other projects is under consideration.
	(*ii*) Adoption of uniform pay-scales.	The Committee recommended adoption of uniform pay-scales and adequate emoluments.	The State Govts. have been advised that :— (a) the remuneration should be adequate to attract suitable personnel; and that (b) the disparity in wages between one area and another should be reduced in order to facilitate interchange of technicians between projects. The question of fixing basic wages will be considered in the light of the recommendations of the Rates & Costs Committee. The report of the Rates & Costs Committee is at present under the consideration of the Government.
	(*iii*) Incentive wages.	Besides basic wages and other allowances incentive wage based on out-turn over a minimum basic wage should be given to the operating and and maintenance staff.	The State Govts. have been advised accordingly.
7.	Cost Accounting.	Cost accounting should be introduced in all the projects and a Central Cost Accounting Directorate should be opened.	Cost Accounting procedure has been adopted on the Centrally financed multipurpose projects, DVC, Hirakud and Bhakra-Nangal. The States who are executing major projects have also been asked to set up Cost Accounting Cells. At chambal, necessary staff has been sanctioned. Further action is being taken. At Kosi, the account organisation is being formed. Rihand, Koyna and Nagarjuna Sagar projects, which are in their preliminary stages of construction are expected to open cost accounting cells at the appropriate time. As the Tungabhadra project (Board Area) has been substantially completed, it is no longer considered necessary to introduce cost accounting procedure on this project. A cost accounting unit is being set up in the CWPC. The Rates & Cost Committee who were asked to submit their recommendation on a uniform cost-accounting organisation for adoption on river valley projects, have submitted their report which is at present under examination by Government.

Metropolitan Water Board of Calcutta

The present water supply of Calcutta and its suburbs is highly unsatisfactory. It is inadequate and does not always conform to the prescribed standards with respect to quality. The area is highly endemic with respect to the gastro-intestinal diseases. It is very important that the Government of West Bengal and the local bodies concerned should realise the grave situation and the immediate necessity for supplying safe water in adequate quantities to the people in the city of Calcutta and its suburban towns on both sides of the River. The problem is colossal. It appears that the only solution lies in the formation of a Metropolitan Water Board which should supply potable water in bulk to the city of Calcutta and Howrah and other municipalities which are adjoining them. It will be possible then to ensure uniform control over the water both with respect to its quality and quantity. Such boards are in existance at Delhi in India and other major cities in many countries in the world like U.SA. and U. K.

Area and Population

The industrial area adjoining Calcutta extends on both sides of the river Hooghly from Ranaghat on the north, to Budge-Budge on the South. The approximate stretch of the river covered by the area is 40 miles. It will be desirable that the Metropolitan Water Board extends its facilities to all the municipal towns situated on both the banks of the river, withia the stretch, including in due course all the towns listed in the Appendix. The design of the intake works and the treatment plant therefore should be based on the population of these towns as expected in 1981. The present population is about 46 lakhs which may be expected to attain approximately 80 lakhs in 1981

Water Consumption

The average water consumption in these towns where there is some form of public water supply varies between 8-10 gpcd. to about 30 gpcd. The water consumption in the city of Calcutta is about 30 gpcd for filtered water. The consumption of water depends primarily on the standard of living, industrial requirement, commercial requirement, public requirement, fire fighting and agricultural requirements. The average rate of consumption, therefore, cannot be the same in all these towns. Considering the rapid rate of industrialisation in these towns, we may anticipate the water consumption to be 25-45 gallons per capita per day in these suburban towns and about 75 gpcd. in the city of Calcutta. Thus the total consumption for all these towns may be estimated as 400 mgd. approximately in 1981.

Present Resources

The existing water supplies in these towns have been tabulated and show in the Appendix. The Calcutta Water Works with its intake works at Pulta is the largest installation that we have. Its present capacity is 80 mgd. of filtered water and proposals are already under way to augment this supply to 150 mgd. by the end of 1961. The Howrah Water Works and the Serampore Works, Baranagar-Kamarhatty Water Works are some of the other major works that are now operating in this area. It would be desirable that these major water works be integrated under the Board and the management completely taken over by the Board.

Proposed source of Supply

So far both surface water and ground water have been tapped for the supply of water to the con sumers in these municipalities. The ground water in most instances is highly mineralised and has high salinity content. Quite often this water is not liked by the consumers, on the other hand the water from the river Hooghly is soft, sweet and is amenable to treatment. It is therefore suggested that in future, augmentation of the supply should be obtained from the river Hooghly. The River Hooghly is subject to tidal effect in the lower stretch. This effect is felt even at the intake works at Pulta which is about 16 miles up-stream from the city of Calcutta. The effect has been more and more pronounced during the recent years. The D.V.C. canal from Durgapur when completed will discharge into the River upstream of intake works at Pulta. This will help to reduce the salinity of the river water. When the Ganga Barrage is complete, we can expect greater flow of fresh water in the river Hooghly and it is expected that the salinity of water at Pulta will not be affected seriously by the tides. It is therefore proposed that intake works at Pulta be improved and expanded to be able to supply the additional quantity of water required by the Board. It can also take additional quantity from an auxiliary Head Works located further upstream, near the discharge point of D.V.C. Canal. Settling tanks at Pulta, if improved and mechanised, can take care of further additional load. There is ample land at the Headworks to provide r.s. filters that may be required to treat the additional quantity of water required by the Board.

Conclusions

1. Metropolitan Water Board be formed immediately
2. Technical staff be appointed to investigate and draw out proper schemes for the supply of water to the municipalities and Corporation under the perview of the Board.
3. The population to be provided with water supply be estimated for the year 1981.

Metropolitan Water Board of Calcutta

4. Major existing installations be integrated under the Board's management.
5. The Pulta headworks be improved and expanded to serve as the prime source of supply.
6. To recommend to the municipalities that the supply to the community should be continuous and single.
7. Liabilities, assets and future commitments of of the Board to be worked out in detail before any definite plan is finalised.
8. Expert Committee may be appointed to go into details and to recommend final proposal for the formation of the Board.

Metropolitan Sewage Board

It is considered that a Metropolitan Sewage Board should also be formed which may ultimately join up with the Water Board to form a combined Water and Sewage Board.

The water supply arrangement alone will not improve the environmental sanitation of the urban areas under reference. It is absolutely essential that human excreta and other waste matters are disposed of by water carriage system in a scientific manner and sewage is treated properly and then discharged into the water course. Calcutta is the only city which has an efficient system of underground sewerage. Sewerage of Calcutta is one of the oldest, but in spite of that there still exist 42,731 service privies within the jurisdiction of the Calcutta Corporation. The towns of Bhatpara and Titagar have skeleton sewerage system where the effluents from the septic tanks of the mills are discharged. The sewage is finally treated by activated sludge process and the effluent is discharged into the water course. Serampore on the west bank of Hooghly is being partially sewered and the sewerage will begin to function from October, 1956. Along with the Water Supply Board it would be desirable to have a Drainage Board for the disposal of waste water and human excreta. Disposal of storm water is also a problem for many of the municipal areas and this should also come within the purview of the proposed Board. The Sewage Board should be responsible for prevention of pollution of rivers like Hooghly and other water courses.

APPENDIX—A

Statement showing the Cities & Municipalities to be included under the proposed Metropolitan Water Board.

Name of city or town	Population		Water Supply			Source		Remarks
	1951 census	Estimated by 1981	Present m.g.d.	Proposed	Augmentation required	Existing	Proposed	
1.	2.	3.	4.	5.	6.	7.	8.	9.
Calcutta	27,68,922	49,00,000	80 m.g.d.	367.5		River	River	
Howrah	4,33,639	7,83,000	v.f.w.90 4	@75.g.c.d.	287.5 mgd 35.25 ,, @25 mgd.	Hoogly ,,	Hoogly ,,	
Ranaghat	28,064	44,000	—	1.1. mgd.	1.1. ,,	—	,,	
Kanchrapara	56,700	88,000	0.214 mgd.	@25 g.cd 2.2 ,,	2 mgd.	Tubewells	,,	
Naihati	55,300	86,000	0.2768 ,,	@25 pcd. 2.15 ,,	1.88 ,,	Mill w/s	,,	
Bhatpara	1,34,700	2,10,000	1 mgd.	@25 pcd. 8.4 ,,	7.4 ,,	Mill w/s	,,	
North Barrackpur & Gunta	42,900	67,000	0.115	@40 gpcd. 1.675	1.6 ,,	Local	,,	
Barrackpore including Cantt	43,000	67,000	—	@25 gpcd. 1.675	1.675	Mill w/s —	,,	
Titagarh	1,35,000	2,10,000	—	@25 gpcd. 8.4	8.4	—	,,	
Khardah	18,534	35,000	—	@40 gpd. o.875 ,,	0.875	—	,,	
Panihati	49,000	73,000	—	@25 gpcd. 1.83 ,,	1.83	,,	,,	
Kamarhati & Baranagore	1,54,000	2,40,000	1.3	9.6 gpcd	8.3	River Hoogly	River Hoogly	
Dum Dum	14,000	26,000	—	0.65 mgd	0.65 mgd.	—	,,	
North Dum Dum	12,000	25,000	—	@25 gpcd 0.60 ,,	0.60 ,,	—	,,	
South Dum Dum	61,400	96,000	.04 mgd.	2.88 ,,	2.84 ,,	River	,,	
Garden Reach	1,09,106	1,70,000	0.48 ,,	6.8 mgd	6.3 ,,	Hoogly	,,	
Budge Budge	32,200	50,000	not known	@40 gpcd. 1.5 gpcd.	1.5 ,,	Hoogly & tubewell	,,	
Bansberia	30,600	46,000	0.08 ,,	@30 mgd 1.15 ,,	1.1 ,,	Mill w/s	,,	
Halisahar	34,700	60,000	0.15 mgd	1.8 mgd.	1.60 ,,	Mill w/s	,,	
Chinsurah (Hoogly)	56,800	80,000	0.07 ,,	@30 gpcd 2.4 ,,	2.33 ,,	River & Tubewells	,,	
Chandernagore	49,900	77,800	0.4 ,,	2.334 ,,	2.0 ,,	not known	,,	
Chamdany	31,543	50,000	—	1.5 ,,	1.5 ,,	—	,,	
Bhadreswar	36,292	62,000	—	1.86 ,,	1.86 ,,	—	,,	
Baidyabati	24,883	40,000	—	1.0 ,,	1.00 ,,	—	,,	
Serampore	74,324	1,16,700	0.955	4.7 ,,	3.7 ,,	River Hoogly	,,	
Rishra	27,465	44,000	—	1.1 ,,	1.1			
Konnagar	20,233	38,000	—	@25 gpcd 1.14 ,,	1.14 ,,			
	45,35,196	77,84,500						
Kotrang	14,177	26,000	—	65 mgd.	0.65 mgd.	—	River	
Uttarpara	17,126	34,000	0.135 mgd.	@25 gpcd 1.02 ,,	0.90 ,,	not known	Hoogly ,,	
Bally	32,128	1,00,000	—	30 gcpd 4 mgd.	4.00 ,,	—	,,	
Uluberia	12,575	20,000	—	@40 mgd. 0.5 ,,	·50	—	,,	
	40,42,202	79,64,500						

Notes & News

How to Extend Cable Life

To help operators extend the usable life of cables (used with such equipment as bulldozers or scrapers) the following suggestions should prove helpful :

Check wear at the cable drum, as wear occurs there very rapidly because of the overlapping or wiping action of the cable as it wraps around the drum. These actions cause fray, and frayed sections or kinks are the points at which a cable is most likely to break.

Kinked cables discovered during daily inspection, however, can often be straightened before damage is too severe. Kinking is caused by improper operation of the cable control, and in most cases by faulty adjustment of the cable control clutch and brake.

Frayed cable is often the result of a bent or misaligned sheave, or a sheave or ejector roller that is binding or not turning freely. When a new cable has been installed, make sure there is approximately two wraps of ejector-apron cable on the cable control drum when the scraper ejector is at the extreme rear position with the apron down. Also, with the bowl at ground level, there should be five or six wraps of cable on the drum.

When a drum is used to control a buildozer, allow sufficient cable for at least four wraps around the drum when the blade is at ground level.

When lowering the scraper bowl to the ground or when lowering the cutting edge for digging, do it with a positive action, keeping the cable under tension.

The ejector will normally move the material out of the scraper rapidly. However do not overstress the cable when moving the thick gambo material. It is normal for some dirt to hang up on the cutting edge when unloading the scraper. As the apron is forced upward by the bulldozing action of the dirt when the bowl is being filled, take up the slack in the cable and then let out enough cable to adjust the position of the apron.

Keep the cable control brake engaged while moving to the dumping area and to the cut, to keep the cable from free spooling.

A cable saver is now available for some scraper units, consisting of a master cylinder and slave cylinder, connected hydraulically. The master cylinder for the ejector cable is located at the forward end of the ejector track and the master cylinder for the bowl lift cable is located on the gooseneck near the upper nest of bow lift sheaves. Both slave cylinders are located on top of the cable control housing. As the ejector and bowl approach their limit of travel, and before contacting the stops, the master cyliner is tripped and actuates the slave cylinder which forces the cable control lever to the hold position Thus, movement of the ejector and bowl is stopped before they reach their limit of travel and the cable is not overstressed.

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Electric Cable is salvaged in shop by use of Plastic Tape

A damaged 15-kilovolt cable was covered with vinyl plastic successfully and economically by the Alabama Power Company, Birmingham, Alabama, by the use of a mechanical taping device widely used for wrapping pipe.

Several thousand feet of 350-MCM, single-conductor, shielded, 15-kilovolt cable had been replaced with a larger-sized cable. It had been in service for several years but was in good condition except that the braided cotton covering over the corona shield had deteriorated. The cable could not be re-used in that condition because pulling it into ducts or conduit would have caused mechanical damage to the copper tape corona shield, resulting in subsequent electrical failure.

The defective braided covering was removed and replaced with 2-inch wide 20-mil thick Scotch No. 21 plastic electrical tape (Minnesota Mining and Manufacturing Company, St. Paul, Minnesota).

The reel holding the cable to be salvaged was set up on a shaft with an adjustable brake. The cable was run over rollers to the point where the tape was applied and then over other rollers to a motor-driven take-up reel. The supports between which the tape was applied were only three feet apart and gave a reasonably rigid section of the cable for the taping machine to work on.

As the cable came off the first reel, the damaged braided covering was removed with a sharp knife and the copper corona braid was cleaned with carbon tetrachloride and inspected closely. Any damage of the corona braid was required by soldering before the tape was applied. The brake on the first reel was adjusted to maintain the proper tension in the cable for taping. The taping machine was adjusted to half lap the tape and give two thicknesses to tape over the shield.

In this way it was possible to salvage about 300 feet of cable per hour at small cost.

Later techniques were developed for applying this same tape to salvaged lead-sheathed cable to prevent corrosion of the lead sheath.

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Our Delhi Letter

(From our special Correspondent)

Not only has Delhi grown in its population in the last five years but every day there are visible signs of forward movement reflected in its growing construction programme of public and private buildings.

Even though this journal devotes itself to the cause of Irrigation and Power it can scarcely fail to take notice of this expansion in Delhi, because of the implications for more and more power.

Presently the impending conferences (in coming November) of the Unesco Organization are going to make an unprecendented demand on hotel accomodation in Delhi. At present Delhi has hardly 900 rooms. 1100 more such rooms are required. Only 50% of this demand is likely to be met with the constructions in hand. The demand for air conditioning, Central heating and lighting is going to be immediate. The occasion is soon going to arise when Political Missions, ECAFE, WHO, I.M.F, I.B.R.D, I.L.O. and Trade Missions are going to arrive in Delhi during the next few months.

Representatives who are accustomed to high standards of living in their own countries will expect the same to be available in progressive India. It is therefore important that the public and private sectors bestir themselves to rise equal to this challenge.

The same story applies in a large measure to offices, railway transport, bus stands, hygenic and sanitary conveniences. Expansion is the need of the hour. For the new structure visualized in the 5-Year Plan, Power development is the key stone.

Results urgently required

The above digression assumes a relevance in the context of urgency all along the line.

In the last analysis the common man has to be enthused with results. He is not so much interested in paper plans for long range measures for the future. For him the efficiency of the white collared officials will be embodied in their success in upgrading and transforming his daily life.

Floods again

The floods in Eastern U.P. and the clamity in the vicinity of Banaras and the grave dislocation of the railway traffic between Delhi and Calcutta are reminders of the fzct that we cannot relax our efforts in the combat against Natures' annual "watery wrath."

Systematic planning coupled with implementation at all levels are the only answer. Drainage needs to be attended to no less than the control measures for floods. Protective embankments, low dams, detention reservoirs and high dams are all needed to meet the various conditions with reliable remedies.

The extent of the problem is so collossal in its incidence and recurence that if a satisfactory degree of control and immunity from catastrophy has to be achieved, a nation-wide campaign is needed. Every Panchayat, muncipality and district board has to cooperate with the Government in the measures like afforestation, contour bunding and protective embankments. These measurs accompanied by the more expensive dam projects can lead to the necessary assured state of protection.

Expansion: need of the hour

From flood control we might go the acknowledged need for the expansion in the Irrigation and Power Departments of the States as well as the Centre.

A large proportion of the natural water wealth of the country is still mostly going waste to the sea. The utilization of irrigation is estimated at not more than about 8%. The standard in utilization for power is about 17 units per captia consumption against 1000 to 3,000 units in the more progressive Western countries. There is thus so much field for work by the engineers in the immediate future.

Exchange of know-how

These facts were brought out in a popular talk given by Shree C. L. Handa, Director, Bhakra Dam Designs before an enlightened audience at the Imperial Hotel on the forum of the Delhi Rotary Club. The role of India as an honoured member in the national fellow-ship of Irrigation and Power enterprises was also stressed by the Speaker who had returned from a recent tour of America and Europe. In these days of quick communications, the know-how evolved in other countries should be acquired and made use of in India's projects, just as India should give willing help to less experienced countries in sharing its knowledge and utilization of the techniques evolved in India.

Such a process is helped by frequent visits to other countries by experts who are well known in various specialized fields of engineering.

Role of Technicians in Leadership

With the statement made by the Prime Minister on the Second Five Year Plan and the Appleby Re-Report, it can no longer be doubted that the responsiblity for development and progress lies as much on the technicians as on the non-technical administrators. In fact the new age depends for its succour more on the scientist and the engineer than on the civilian overlord who, during the British regime, was considered indispensable for law and order. The administrators of the future will have to be well-versed in their knowledge of the laws of atomic energy, hydro-electric power development, Steel manufacturing plants and aircraft factory techniques. It opens a new chapter in India's development and the race for administrative careers must be accompanied by the acquisition of adequate knowledge so that the problems of technology are dealt with on real merits rather than literary dialectics.

Needed Workers

The need of the country is for "Workers" at all levels—Workers who advance their profession over real hurdles in day to day problems and not content themselves with having only pushed the files away from their tables with so called "administrative and finnancial jargon", which has unfortunately been developed in India for hindering a work rather than helping it. This new approach must be developed at the grass roots, by all sons and daughters of India, who are participating in the tasks of building the country.

Editorial Comments

The colossal damage that floods cause in our country is not generally comprehended by the people for various reasons. One is that these being annual in occurrence, we have become habituated to their arrival; secondly, the city dwellers who primarily constitute the vocal section of our society are not seriously affected by it. Thirdly, the silt deposition on agricultural land due to floods helps the villagers affected to reap a rich harvest immediatly afterwards. Even so, if we total our minimum flood damages of the last six years, not including the human and animal lives lost, we come to the figure of Rs. 287 crores, as given by Sri Kanwar Sain, Chairman of the CW & PC. But how much of it can be compensated by the State? As much as Rs. 45 crores were spent by the Central and State Governments during this period towards flood relief.

* * *

It was, therefore, a gratifying news that an Inter-State Conference between India and Pakistan was held recently to discuss the problem of flood control, particularly in the eastern region. The two States are in a peculiar political relation to each other and, therefore, one should be chary to say anything about them. However, the flood situation creates such a basically human problem that one should not miss to thank these two countries for having condescended to get together and agree at least to exchange informations necessary for flood control measures. Some of the important recommendations approved by the Conference were :

(1) Flood warnings to be given from Dibrugarh, Gauhati, Patna, Silchar, Gomti, Khawai and Dholal from India to Pakistan : (2) flood warnings from Atrai in Pakistan to be given to India ; (3) heavy rainfall data from Shillong to be transmitted to Pakistan ; (4) heavy rainfall data from Sylhet and Habibganj in Pakistan to be sent to India ; and (5) India will endeavour to furnish such other information relating to the Brahmaputra valley or other assistance as may be considered necessary by the two chairman for formulating flood schemes in East Pakistan.

However, the *procedure* of exchanging the above categories of information seemed to have remained undecided at the Conference. Let us hope this has been made possible by now. And let us also hope that this cautious and circumspect approach to a problem of mutual concern will generate greater enthusiasm and better climate of cooperation in future to tackle broader problems involved.

* * *

Plans drawn up by the Central Water and Power Commission for the nationwide development of inland waterways at first generated in us a flood of enthusiasm. This was so because we have been stressing many a time that our Railway System will be hard put to meet the strenuous demands involved in the execution of the Second Five-Year Plan. Coastal shipping, road transport and inland navigation, we pleaded, need much more attention than they have so far obtained. The CW & PC, we are glad, is thinking in bolder terms than previously about river navigation and transport. But at the same time, we are inclined to suspect that an attitude of giantism may have entered in the framing of its plan. To link up Calcutta with Cochin or the East Coast with the West Coast is a brilliant and even practical idea but the point that demands urgent attention, is: how can inland navigation facilities and river transport services be improved and extended from year to year? Is it necessary to remind ourselves again and again that the Second Five-Year Plan has already begun and its first year half over ? May we, therefore, suggest that without neglecting the broad long-term planning of inland navigation, those parts of the CW & PC Plan should be taken up for immediate execution that will have short term value ? To our mind the word "planning" sometimes inculcates an attitude of looking far into the future (which is also necessary) in a leisurely fashion, forgetting that 'future' is composed of a number of successive 'immediate presents'. Of course the idea of planning itself contains the germinal seed of such an attitude and therefore we should be vigilant.

* * *

Sometimes back there was news in the daily press that Sir Claude Inglis, a reputed hydrologist, was invited by the Government of India to study the Kosi Project in all its aspects. He did so and submitted a report which is known to be highly critical of the basic approach and premises of the Kosi Project. Sir Claude is said to have pointed out that the problem of Kosi is not so much of "routing of water" but of "routing of sand and silt". Kosi has been a problem river not only to the people of Bihar but also to our engineers. It has been under discussion for years and plans have been made and unmade several times. Has Sir Claude something new and substantial to say ? We learn that his present opinion runs counter to that he held sometime in 1945. This makes confusion worse confounded, if our information is correct. There are two ways of diminishing confusion. One, by not worrying about it ; and another, by exercising one's intelligence in studying the various viewpoints and their respective arguments, and the scientific data marshalled by each, and by model experiments. We, therefore, wrote to all concerned so that we might get a copy of the Inglis Report. Unfortunately it (even a summary) was not released even to a technical Journal like ours, which no one can brand as sensationalist. We have, therefore, no other course left except accepting the first alternative, namely to cease worrying about it.

Book Review

Streams, Lakes, Ponds BY ROBERT E. COKER, *The University of North Carolina Press, Chapel Hill, North Carolina, U.S.A.*, 345 *Pages*, $6.00

The author of this fascinating text is Kenan Professor of Zoology, at the University of North Carolina, and a distinguished zoologist. In simple and readable terminology, he covers a difficult subject of the story of life in water and its many ramifications.

The book is divided into three parts. The first portion describes the various properties of water and brings out the salient facts about this universal fluid, the affects of heat and light on it, and the chemical and biological relations of gases. The stratification of water, the basic nutrients, as well as colour, turbidity, odour and taste are also dealt with here. The second part covers a discussion on running water and the problems of pollution, while the concluding part deals with the various aspects of life to be found in still water—the plants, lower animals, jointed-leg animals, and vertebrates of the lake. The occupants of the fish pond are also described and and suggestions are made regarding their productivity. There are a number of illustrations of water plants and animals, and photographs of the lake and other water district sceneries. There is an excellent bibliography on the subject.

Streams, Lakes and Ponds are fertile grounds for those who wish to ramble with nature and unearth its secrets. For those who wish to do so without rambling, this book offers excellent opportunities. In the opinion of the reviewer the publication should be of interest to conservationists, fish culturists, hydraulic and sanitary engineers, scientific agriculturists, and industrialists, for its succinct and well coordinated account of basic facts and principles concerning waters and the life prevailing in them.

S. K. GHASWALA

* * *

Geologie Des Barrages et des Amenagements Hydrauliques BY M. GIGNOUX AND R. BARBIER, *Masson et Cie, Editeurs*, 120 *Boulevard Saint-Germain, Paris VIe, France*, 344 *pages*, 3500 *Fr. Francs.*

This is a highly authoritative work on the geology of dams and ancillary works written by two professors of the famed French university of Grenoble, which is well known the world over for its work on hydraulics.

The work is divided into 7 chapters. The introductory chapter covers the general topography and forms an elementary account of engineering geology necessary for a good appraisal of dam design and foundations. Along with the theoretical discussions, the authors have introduced practical examples of dams and their foundations which considerably add to the interest. Among the structures described here are the Castillon Dam in S. E. France, the highest Franch arch dam ; the Sautet Dam on the Drac ; the Chambon Dam on the Romanche, which is a typical example of reverse slopes and irregularities in sub-alluvial bedrock in a glacial valley which was not studied sufficiently before the construction was commenced resulting in an underestimation of the depth of "reversed slope" ; and problems in site evaluation of a dam project in an epigenic valley.

The second chapter deals with the surface layer of the earth and sites examples of the difficulty in distinguishing between bed-rock and surface coverings. The Tignes Dam, Europe's highest arch dam (180 m.) ; the Aussois Dam ; and a few others are mentioned as typical examples in this connection. Ground movements in the form of landslides, undercutting and erosion are next covered, and the details of the phenomena explained. The fourth chapter which is fairly exhaustive takes the readers into the mysteries of foundation engineering connected with dam construction, describing methods for founding structures on rock, alluvium, schist and other common varieties of soils. The section of materials of construction for dam will interest many engineers who like to study the subject from a geological viewpoint. The remaining three sections deal with ancillary topics, viz, diversion tunnels ; characteristics of rocks ; galleries for inspection ; materials, methods and equipment for drilling, injection grouting, and examples in support of these varied works. A good bibliography is also appended.

An unusual feature of the text is that an explanation of all figures and photographs is given in English in addition to French. This enables the non-French speaking readers to obtain a general idea of the subject matter.

All practising engineers connected with engineering geology and dam design should necessarily have a copy of this excellent text.

S. K. GHASWALA

ON TOUGH CONSTRUCTION JOBS

USE

GOODYEAR

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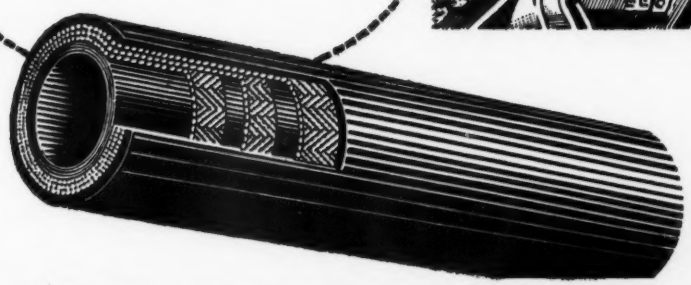

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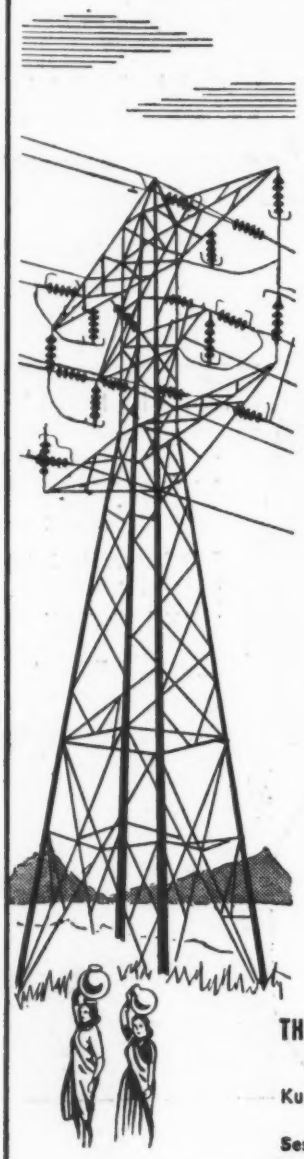
more power to the people in the second five-year plan



From 11,000 million units to 22,000 million units is, indeed, a spectacular jump, but that's the increase in electricity generation proposed in the Second Plan. The Plan, also envisages 35,000 miles of new transmission lines.

The significance of this increased generation—and more lines—is that electricity the ultimate in service, will reach out its helping hand to more factories and farms and homes — adding up impressively to the sum-total of the nation's well-being and prosperity.

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